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The Historical Geography of Rice Culture in the American South.

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The historical geography of rice culture in the American South

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The Historical Geography of Rice Culture
in the American South

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ABSTRACT

The South Atlantic Hearth was the dominant rice producer during the colonial and antebellum periods. Rice production in the region declined after the outbreak of the Civil War, but the region kept the leading position until the 1880s. Along the Lower Mississippi River in southern Louisiana a remarkable amount of rice was produced from the antebellum period, reaching a peak in the 1890s. A major regional shift occurred when rice culture on a large-scale, commercial basis developed in southwestern Louisiana during the 1880s by transplanted Midwesterners. From there it spread into southeastern Texas during the last decade of the nineteenth century, and into the Grand Prairie during the first decade of this century. During this century, it gradually spread along the Lower Mississippi River Valley in eastern Arkansas, Mississippi Yazoo Basin, northeastern Louisiana, and southeastern Missouri. The Gulf Coast Prairies and the Lower Mississippi River Valley remain the most important two rice-growing regions in the South.

Water supply and management techniques, farm machinery for rice culture, rice varieties, crop rotation methods, and other cultivation practices have all changed through time in the South, and the development of the agricultural technology for rice farming has contributed to the

increasing yield of rice. Southern rice farmers have organized their rice cooperatives for rice marketing, milling, and drying and storage. They also benefited from many other organizations and institutes such as the rice experiment stations, the rice promotion organizations, the Rice Millers Association, and other governmental agencies. The role of government became remarkably active through the production control and price support system after the first Agricultural Adjustment was enacted in 1933.

In this study, the historical geography of rice culture in the American South is explained in terms of economic processes, technological processes, agronomic processes, social processes, and political processes. All these processes are also related with each other. Despite the tremendous potential for rice production the future of the southern rice industry depends on various factors including agricultural technology, socio-political environment, international demand for the U.S. rice, and the relative importance of alternative crops.

CHAPTER I

INTRODUCTION

The United States today produces about 1.8 percent of the world's rice, slightly more than 50 percent of which it exports to other countries.[1] The South produces more than three-quarters of the nation's rice with California, the only U.S. rice-producing region outside the South, producing the remainder. Although small quantities have been grown in scattered locations throughout the South, virtually all production has been on favored sites in the Atlantic-Gulf Coastal Plain and the Mississippi River Floodplain, specifically on flat lowlands or low-lying floodplains.

The spatial pattern of American rice production has varied throughout its history. Rice was first grown in large quantities along the Carolina-Georgia Coast, and after the Civil War a remarkable amount of rice was also produced in southern Louisiana along the Mississippi River. During the late nineteenth century and the early twentieth century, the Gulf Coast Prairies and the Lower Mississippi River Valley emerged as major rice-producing regions in the South.

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1 During the six years from 1980 to 1985, the U.S. produced 857.1 million cwt of rough (unmilled) rice, and exported 437.7 million cwt of the U.S. rice.

Today, these two rice-growing regions account for most of the commercial rice production in the South.

Present day rice culture in the South has yielded completely to modern mechanization, organization, and research. Systematic irrigation systems, large-scale mechanization, bulk rice storage, airplane applications, and high rates of chemical use are common characteristics of rice culture throughout southern rice-growing regions. The emergence of these easily defined agricultural regions depended upon a variety of factors, among them being an environment suited to the production of rice, persons knowledgeable in its culture, and an economy that provided markets for its product.

Yet, the process of the evolution of southern rice-growing regions was slow and fitful. Moreover, despite the apparent homogeneity surprising variation exists among the many sub-regions as to the techniques of growing, harvesting, and marketing the product.

This study focuses the development and functioning of the southern rice-growing regions. It deals with those factors that explain best how and why the regions came to be the way they are. It explores the American antecedents in the eastern South as well as the shift in location, from the Carolina-Georgia lowlands to the Mississippi River Valley and beyond. It examines the physical and human factors necessary for the regional changes and persistence.

A) Framework: Organization

The framework of this study is illustrated in Figure I-1. The dissertation is composed of nine chapters. The first chapter is an introduction; the last, a summary and conclusion. The seven intervening chapters discuss economic processes, technological processes, agronomic processes, social processes, and political processes in an explanation of rice culture through time and space.

Economic processes are concerned not only with the production, consumption, and distribution of the rice crop but also with its relation to other agricultural commodities. The seasonal and annual fluctuations of rice economy are extremely complicated, and beyond the scope of this study. Studies on domestic and international rice price, consumption, and marketing can be conducted efficiently using short-term analyses. Because this study covers hundreds of years, only long-range fluctuations of rice economy are considered. However, those production aspects that are directly significant to the changes in rice-producing regions are included. Economic processes are examined in the second chapter, which focuses on the rice-producing areas, and in the eighth chapter, which deals with the role of government on rice economy.

Technological processes are examined in the third and

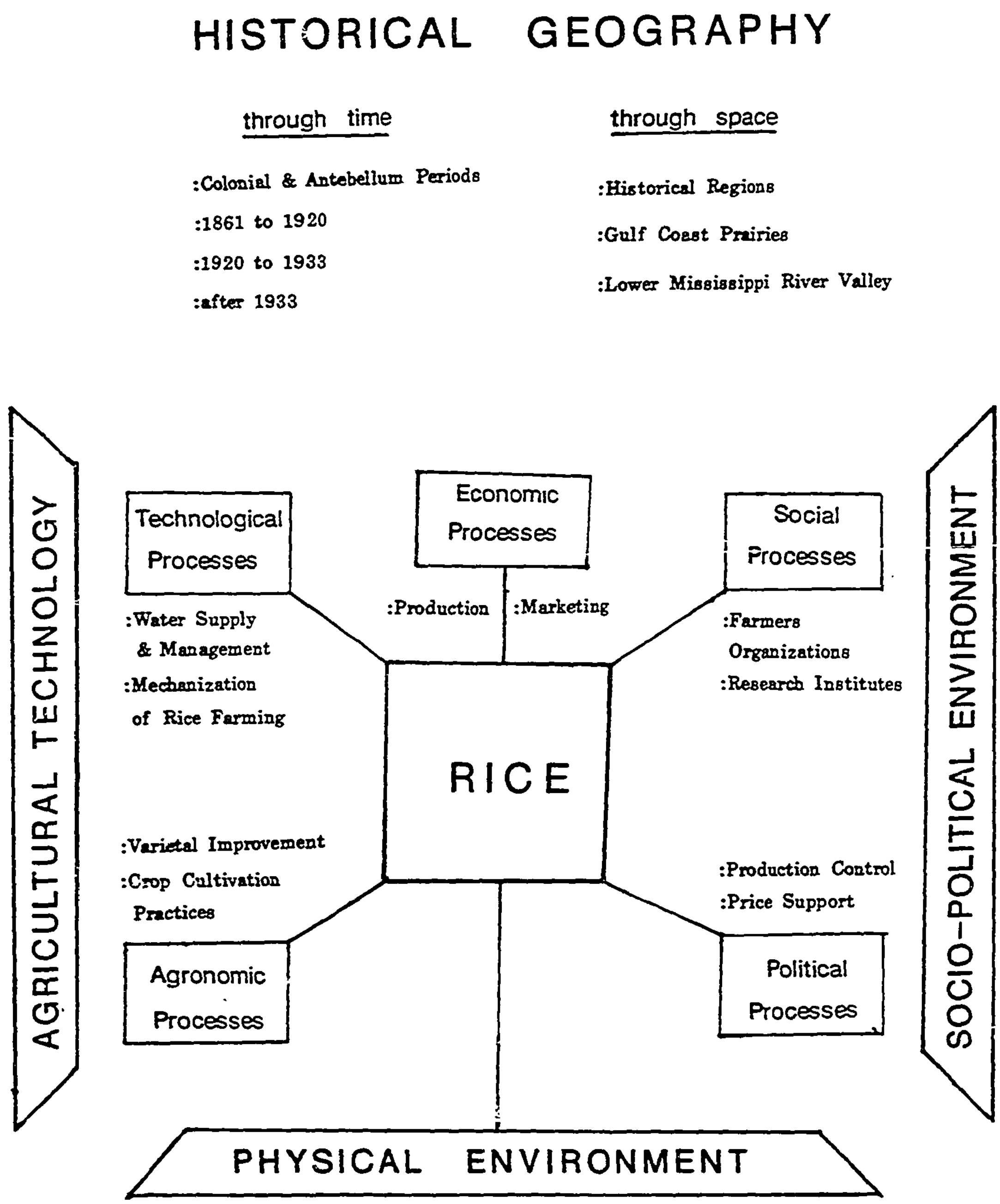

Figure I-1. Framework of the Study.

fourth chapters, the third dealing with various methods of water supply and management; the fourth chapter, the development of major tools and machinery in the southern rice farms. Agronomic processes are covered in the fifth and sixth chapters.

Chapter Seven, dealing with social processes, describes the organizations and institutes concerned with rice production in the South, such as, research institutes, farmers cooperatives, and promotional organizations. Chapter Eight deals with governmental roles that have been significant in the changes and maturation of the southern rice culture. The production control and price support systems that have been especially significant since the Agricultural Adjustment Act of 1933 are examined in this chapter.

Innovation and diffusion, transportation development, population increase, and industrial (especially milling industry) development are examined when these components are especially significant to the explanation of the southern rice culture.

B) Background: Literature Review

B-1) Agricultural Geography

Agriculture has been, perhaps, the first in order among man's activities that has modified the surface of the earth.

In the past, most people were engaged in agricultural production. Today, agriculture occupies one-third of the earth's land surface and employs 45 percent of the working population (Grigg 1984, p. 13). Thus, it is proper that agriculture remains one of the major fields in geography.

Early agricultural geographers emphasized the relationship between agriculture and physical environment. They believed that variations in physical environment determined spatial variations in agricultural activities (McCarty 1954, p. 267). Later, they began to understand that the same physical conditions of the land could have quite different meanings for the peoples with different attitudes and technologies. They found that not only physical characteristics of the land but also agricultural technology, social and economic conditions, and political decisions should be considered in the explanation of agricultural regions and their changes.

Both systematic (topical) analyses and regional studies have been used to describe agricultural diversity. The topical study is concerned with the distribution of a particular theme or commodity and with the explanation of the pattern; the regional study is concerned with the various aspects of agriculture of a particular region (McCarty 1954, p. 259; Grigg 1984, pp. 14-16). The Isolated State, originally published in 1826 by a German economist, J. H. von Thünen, had a profound impact on English-speaking geographers, when it was translated into English in 1966. He assumed that the distance from the central city is the dominant factor for a land-use pattern of an imaginary world. Torsten Hägerstrand, focusing on the decision-making processes of individuals, studied how Swedish farmers adopted new farming methods. Spatial variations in agriculture, he argued, were results of many decisions made by many individual farmers (Grigg 1984, p. 18). David B. Grigg organized his textbook An Introduction to Agricultural Geography into three parts: the first part is concerned with the economic environment; the second, with the physical environment; and the last, with the social, political, and cultural environments. J. E. Spencer and Roland J. Horavath (1963, p. 93) identified six categories of agricultural processes: psychological, political, historical, technological, economic, and agronomic. They believed that these processes were essential to the origin, change, and maturity of an agricultural region.

Agricultural geographers are not content to describe the agriculture of an area in static terms. They understand that the processes of past agricultural development can explain contemporary geography of agriculture. Hence, the importance of historical geography of the major farming systems.

B-2) Historical Geography

In North America, Ralph H. Brown and Carl O. Sauer were two great innovators in historical geography (Clark 1954, p. 83). Brown published *Mirror for Americans, Likeness of the Eastern Seaboard, 1810* in 1943 and *Historical Geography of the United States* in 1948. The former is a literary description of East Seaboard regions in 1810 as viewed by an imaginary geographer; in the latter, he explained major regional changes during the settlement of the United States.

Sauer regarded geography as a genetic science which accounts for origins and processes. He claimed that human geography should deal with the problems of cultural growth and change. He stated:

> Every human landscape, every habitation, at any moment is an accumulation of practical experience and of... residues.... If the object is to define and understand human activities as areal growths, we must find out how they and their distributions (settlement) and their activities (land use) came to be what they are (Sauer 1941, p. 4).

Sauer's genetic approach made a significant contribution to the development of historical geography in America. Andrew H. Clark (1954, p. 71) explained:

> The genetic approach to geographical study inevitably leads to an examination of the past. This does not mean that one is to seek simple causes in the past to account for contemporary conditions, but rather that the conditions observed at any period of time are to be understood as momentary states in continuing and complex processes of change.... The genetic approach focuses attention on processes, for whatever interests us in the contemporary scene is to be understood only in terms of the processes at work to produce it. It is not, therefore, a search for origin in any ultimate sense, but rather views the present, or any particular time, as a point in a long continuum.

Robert D. Mitchell (1987, p. 3) defined geography as the study of the relationships existing between people and place as they are reflected in environmental, distributional, and regional expressions, and he continued to define historical geography as the study of how and why these expressions persist and change in place and over space through time. John Fraser Hart also noted the importance of historical geography, in the statement that "present patterns are but a momentary reflection of continuing processes of change" (Hart 1982, p. 23).

B-3) Historical Geography of Rice Culture in the South

Pete Daniel's Breaking the Land: the Transformation of Cotton, Tobacco, and Rice Cultures Since 1880 is one of the most detailed studies on southern rice culture. Political processes are emphasized without ignoring other processes in the explanation of the development of southern rice culture. Since this study covers only the period after 1880, it does not deal with the rice culture of the South Atlantic Hearth along the Carolina-Georgia coast.

Mildred K. Ginn's "A history of rice industry in Louisiana" documents the origin and development of Louisiana's rice culture up to 1898. This is the best study on early rice cultivation in southern Louisiana and on the origin of rice culture in southwestern Louisiana.

Chan Lee's *A Culture History of Rice with Special Reference to Louisiana* focuses on the river rice in southern Louisiana. Lee did intensive field surveys in the late 1950s and recorded the last relics of river rice in southern Louisiana. He paid special attention to the irrigation methods of river rice in southern Louisiana.

There are some valuable studies concerning the rice culture in the South Atlantic Hearth: Sam B. Hilliard's "Antebellum tidewater rice culture in South Carolina and Georgia"; A. S. Salley, Jr.'s *The Introduction of Rice Culture into South Carolina*; Duncan Clinch Heyward's *Seed from Madagascar*; David Doar's "Rice and rice planting in the South Carolina's low country"; Lewis Cecil Gray's *History of Agriculture in the Southern United States to 1860*; Robert F. Allston's "Rice"; and James Herbert Stone's *Black Leadership in the Old South: the Slave Drivers of the Rice Kingdom*. These studies made clear many aspects of rice farming systems practiced in the South Atlantic Hearth, though all of these studies are not consistent with each other in the timing and manner of rice introduction into South Carolina.

CHAPTER II

RICE-PRODUCING REGIONS IN THE SOUTH

A) HISTORICAL REGIONS

The rice commercially grown in the South [Oryza sativa L.] is not a native plant, having been introduced from the Old World in the seventeenth century.[1] Originally domesticated in India or Southeast Asia, it has spread to all continents except Antarctica, and is now the principal cereal grain of the world (Lee, 1960). It was first introduced into North America by early English colonists in Virginia. Sir William Berkeley carried on an experiment to raise rice at a settlement on the James River in Virginia in 1647; his first efforts yielded sixteen bushels from a half bushel of rice seed (Ginn 1940, p. 4). Farther south, rice culture was attempted in the Cape Fear River area in North Carolina in 1669 with gratifying success (Evans 1902, p. 4). Further attempts probably were made, but little record has

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1 Commercial rice should not be confused with America "wild rice." Wild rice [Zizania aquatica L.] is indigenous to North America, but is a totally different genus. Wild or Indian rice was a major food of Indians who lived near the Great Lakes and, in fact, is still consumed by both Indians and Whites.

been left. No doubt tobacco's success as a cash crop militated against further experiments with rice.

A-1) South Atlantic Hearth

Despite its earlier introduction in Virginia, the credit for successful rice culture belongs to South Carolina. One of the traditional accounts is that rice seed was introduced in South Carolina in 1693 or 1694 by a captain of a ship sailing from Madagascar who gave a bag of rice to Landgrave Thomas Smith, who planted it in his garden (Elliot 1851, p. 305). Other scholars, including Salley (1919, p. 11), have argued that the rice culture in South Carolina was begun before 1690 not as a result of the accident but of a prearranged development plan by South Carolina Proprietors. For example, we know that on July 23, 1687, the South Carolina General Assembly passed "an act to ascertain the price of commodities [including corn, Indian pease, English pease, pork, beef, tobacco, and tar] of the country's growth." Rice was notable for its absence from the list, probably indicating that it was not present in the Colony or that it had not yet become important enough to mention. However, only four years later the assembly passed "an act for the encouragement of the making of engines for propagating the staples of the colony," one that enabled Mr. Peter Jacob Guerard to get an exclusive patent for the invention of a pendulum engine, which was reported to "husk rice much better and in less time and labor than any other that heretofore had been used in the province." A fair inference from this statement is that rice either had already become, or was anticipated to be a staple. Furthermore, an act passed on March 16, 1695, again included rice as one of the major commodities [indigo, cotton, silks, rice, beef, pork, etc.] in the colony (Salley 1919, pp. 3-6; Smith 1904, p. 2; Gray 1933, p. 278). What can be certified from various sources of historical documents and works may be simply that rice culture was first introduced in the state before 1695, through Charleston (Hilliard 1978, p. 93; Gray 1933, p. 278; Smith 1904, p. 2)

Until the Revolutionary War, rice culture flourished without serious interruption, and the amount of rice exported increased steadily after the second decade of the eighteenth century (Figure II-1; Appendix I). As more acreage came into production, rice culture spread from Charleston along the South Carolina coast until, by the middle of the eighteenth century, it extended from Georgetown County in South Carolina to Chatham County in Georgia (Hilliard 1978, p. 93; Smith 1985, p. 21).

Production continued to increase as did exports. The early nineteenth century saw the heyday of Carolina rice; the rice-growing areas stretched from the Cape Fear River in North Carolina to the St. Johns River in Florida, with exports reaching a peak of 1.28 million cwt of milled rice

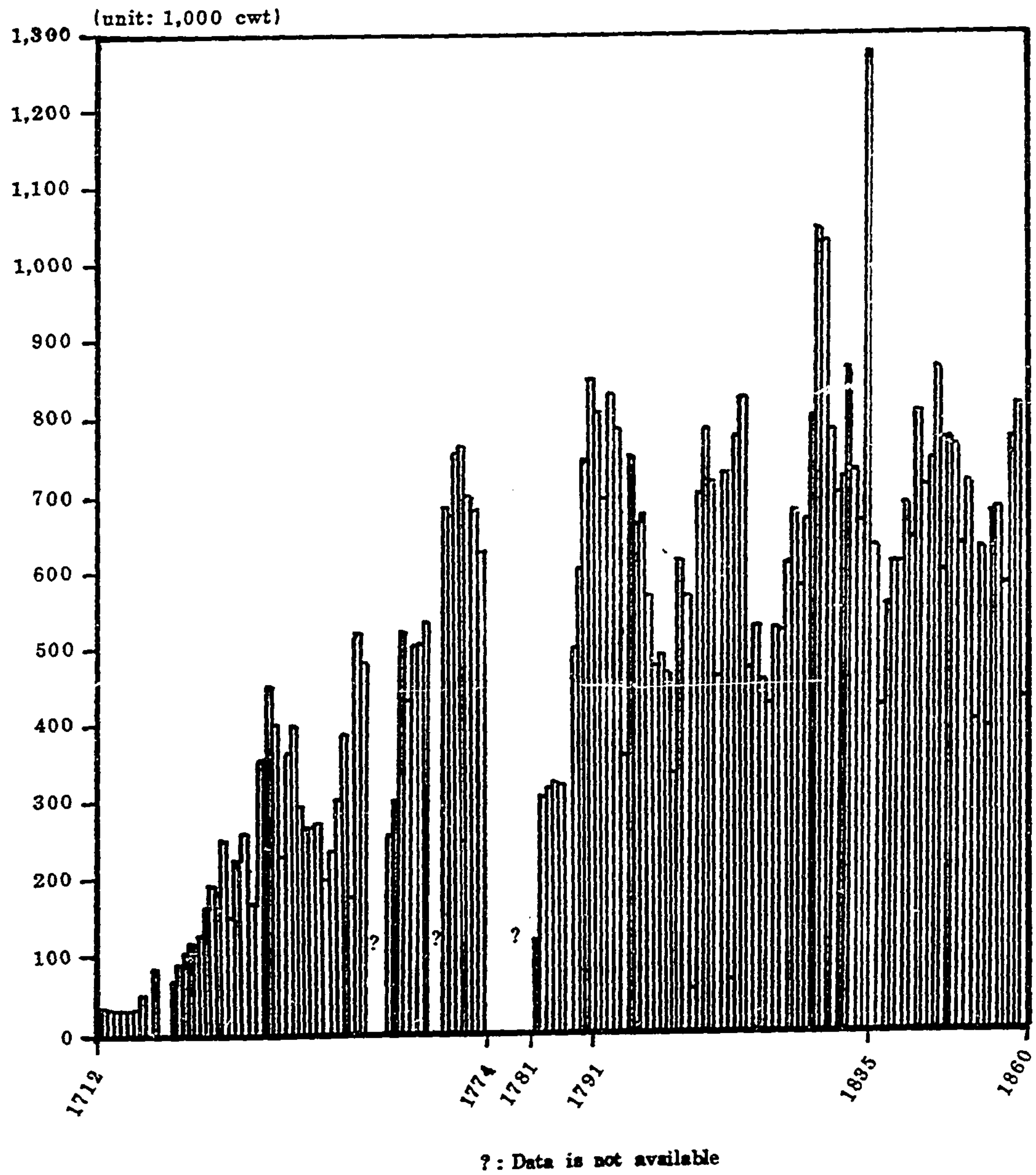

Figure II-1. Exports of (Milled) Rice Shipped from the United States, 1712-1860 (Gray 1958, p. 1030).

in 1835 (Figure II-1; Appendix I). Although scattered production occurred inland and along the Gulf Coast, the South Atlantic Hearth remained the unchallenged leader in rice culture throughout the antebellum period. The U.S. Census of Agriculture for 1840 showed South Carolina and Georgia producing about 0.98 million cwt and 0.20 million cwt of rough rice, or 75 percent and 15 percent, respectively, of the national total production (Appendix II). The crop of 1849 was the largest ever recorded by the U.S. Census for the South Atlantic Hearth. In that year, the three states of South Carolina, Georgia, and North Carolina produced 3.3 million cwt of rough rice, or about 95 percent of the nation's output (Appendix II), a crop that employed some 125,000 slaves working on over 500 rice plantations in the South Atlantic Hearth (Smith 1985, p. 9).

Soon after rice culture was introduced in the state, South Carolinians found that rice did well under irrigation and could be well adapted to the inland (cypress) swamps above tidewater (see Chapter III for more details on irrigation systems). Early rice fields were located on river floodplains in the inland swamps, where they were flooded by stream flowage, but they began to shift to the tidewater swamps sometime before the Revolutionary War.[2]

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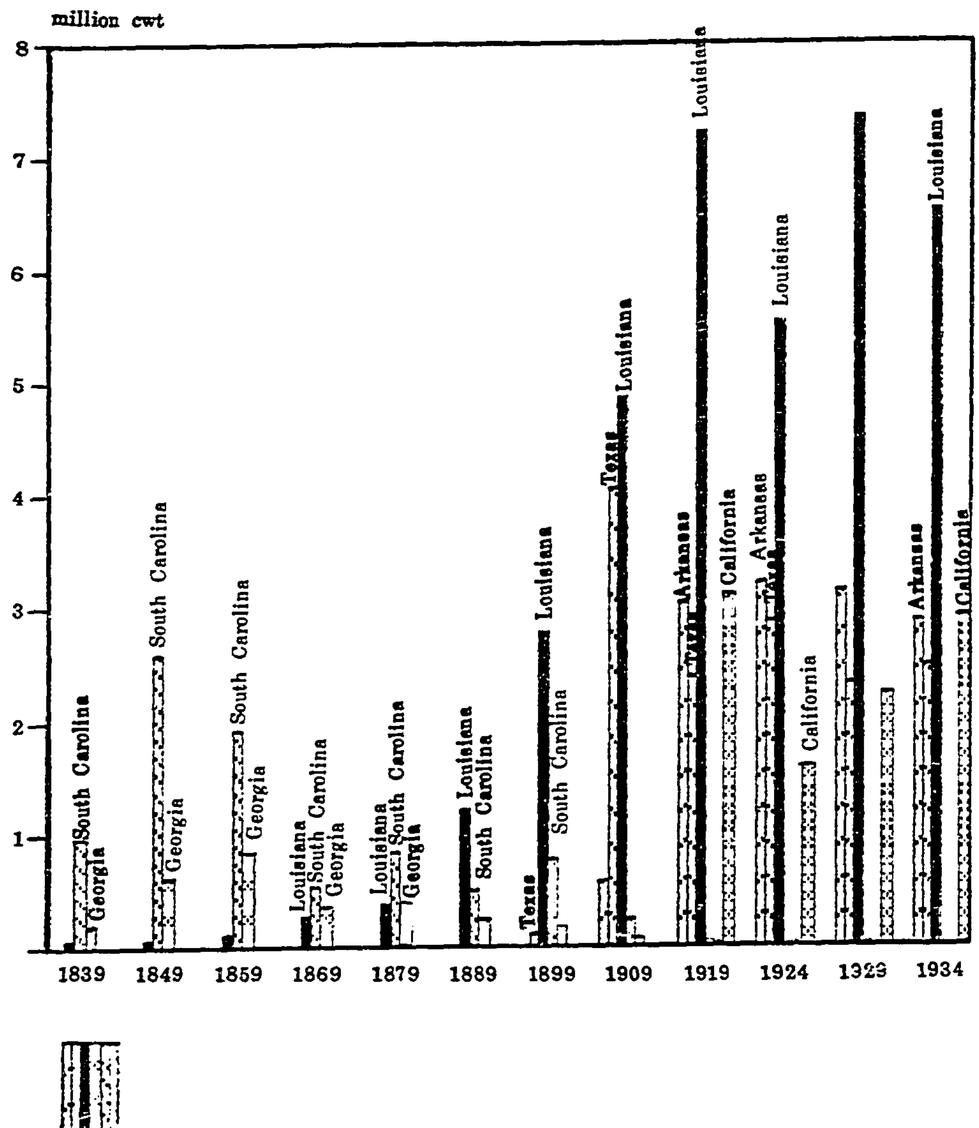
2 Just when the tidewater irrigation system began is unknown. Phillips (1929, p. 116) believed that it was originally devised by McKnewn Johnston in 1758 near Winyah Bay, South Carolina.

Although the shift from inland swamps to the tidewater was not immediate, by the turn of the nineteenth century the bulk of rice was grown on swampy coastal lowlands, where the water level of the rivers fell and rose with ebb and flow of tide (Gray 1933, p. 280; Smith 1985, p. 21; Hilliard 1978, p. 98).

Rice culture was inherently labor intensive, making it a classic plantation crop, and slavery was the only labor system used throughout the colonial and antebellum periods. In addition to the inherent financial advantage of slave labor, the slaves could be forced to work in the mosquito-infested swampy areas in hot humid conditions, often standing in knee-deep muck.

Rice culture in the South Atlantic Hearth declined abruptly with the outbreak of the Civil War. The rice culture was restored during the postbellum period but production never recovered to the antebellum level. Prior to the war, the South Atlantic Hearth produced 2.90 million cwt of rough rice, or 96 percent of the national total. After the war, the total dropped to 0.92 million cwt in 1869, 1.34 million cwt in 1879, and 0.82 million cwt in 1889 (Figure II-2; Appendix II). By 1889, the leading rice-producing region in the South had already shifted westward, with the South Atlantic Hearth accounting for but 39 percent of the national total.

Many factors were responsible for the decline of rice



The bars represent six rice-producing states from the left to the right
Arkansas, Texas, Louisiana, South Carolina, Georgia, and California.

Figure II-2. Rice (Rough Rice) Production in the United States, 1839-1934 (U.S. Census of Agriculture).

culture in the South Atlantic Hearth (Lee 1960, p. 68; Phillips 1951, pp. 91-92). A major one was an inadequate labor supply. During the war, and after the conflict no suitable replacement for slavery was devised. Sharecropping evolved on cotton plantations, but the complex nature of field flooding, levee maintenance, and rice milling militated against subdividing into cropper units. It was simply too complex an operation to break into smaller units. Equally important was the relative disadvantage the South Atlantic Hearth had in the acquisition and use of newly developed grain harvesting machinery. Moreover, many of the rice planters in Louisiana and Arkansas were transplanted Midwesterners who were well acquainted with the machinery that had developed for grain harvesting farther north. Such machinery was well suited to the newly emerging rice regions of Louisiana, Texas, and Arkansas, but was inappropriate in the much smaller and boggy rice fields of the South Atlantic Hearth. With the mechanization of rice culture, the Gulf Coast Prairies and the Lower Mississippi River Valley produced rice at a far lower cost than the South Atlantic Hearth. A third factor was related to environmental degradation associated with the area, such as freshets and storms. Freshets [sudden overflows of streams resulting from heavy rains], caused by expansion of cleared land in the interior and its associated increased runoff, became so frequent and severe as to disrupt or damage the tidewater levee system. More severe hurricanes along the South Atlantic Hearth were recorded after the year 1880, adding to the devastation. These environmental disasters, to be sure, accelerated the decline of the rice culture in the South Atlantic Hearth.

A-2) Southern Louisiana along the Lower Mississippi River

Rice seed was brought into Louisiana as early as 1718 by the group of French settlers that founded the city of New Orleans (R.J.[3] 35 [2], p. 23; Ginn 1940, p. 7). According to a proclamation issued by the India Company at the opening of the year 1720, the Company was to purchase staple products[4] of the colony from local growers, including rice. Again in September 1721, it was decreed that rice should be delivered and sold at the Company's warehouses at New Orleans, Biloxi, or Mobile (Gayarre 1919, pp. 286). The minutes of the Superior Council of Louisiana, dated October 1723, noted that rice was produced in a considerable amount (Taylor 1956, p. 71).

Throughout the colonial and antebellum periods, rice was widely cultivated along the Lower Mississippi River but not nearly as intensively as in the South Atlantic Hearth. Production was small, too, for the state of Louisiana

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3 R.J. represents the Rice Journal magazine in this dissertation (Appendix V).

4 The products in the colony were silk, tobacco, rice, wheat flour, barley, oats, deer skins, and hides.

accounted for only 2 percent of the 1849 U.S. rice output and 3 percent of the 1859 output (Figure II-2; Appendix II). Plaquemines Parish, located on both sides of the Mississippi River from the Gulf to within a few miles of New Orleans, was the focal point of rice culture along the Lower Mississippi River, accounting for 35 percent of the state's rice in 1849 and 75 percent in 1859.

During the years immediately following the end of the Civil War, rice production increased at a rapid rate in southern Louisiana along the Lower Mississippi River, reaching the zenith around the 1890s, when a mechanized rice culture was emerging in the prairies of southwestern Louisiana (Figure II-3; Figure II-4).

The rice growers in southern Louisiana along the Lower Mississippi River clung to their traditional methods and were slow in adopting mechanized rice culture (Daniel 1985, p. 59). The relative disadvantage of their rice fields was one of the major factors that caused rice production in southern Louisiana to decrease gradually in favor of southwestern Louisiana prairies. As rice production increased in southwestern Louisiana, the river rice in southern Louisiana became relatively less important and, by the 1960s, was but a pittance (Figures II-3; Figure II-4; Figure II-5; Figure II-6; Figure II-7; Figure II-8).

Figure II-3. Rice (Rough Rice) Production in the South in 1879 (Based on: the 1880 Census of Agriculture).

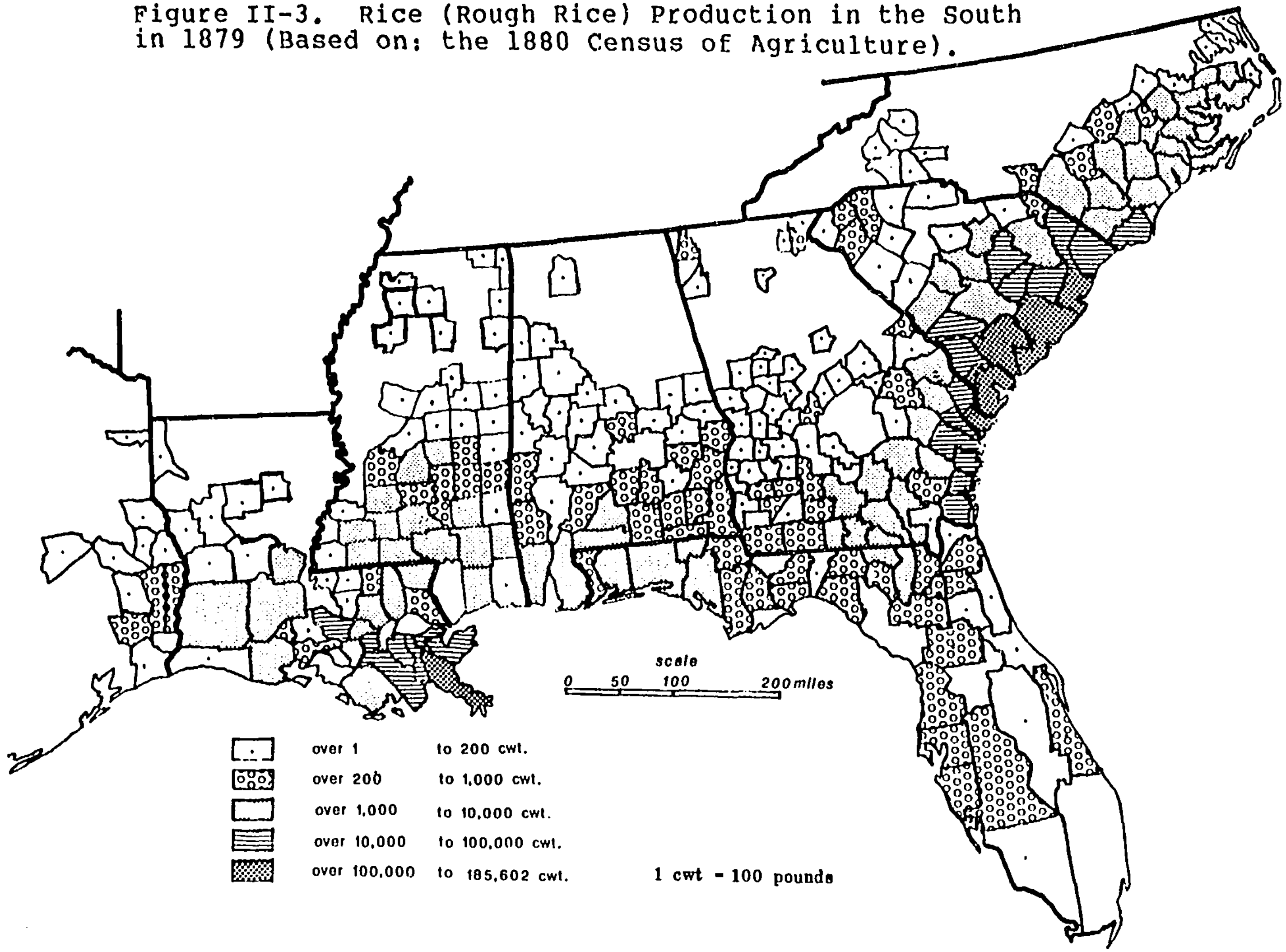


Figure II-4. Rice (Rough Rice) Production in the South in 1899 (Based on: the 1900 Census of Agriculture).

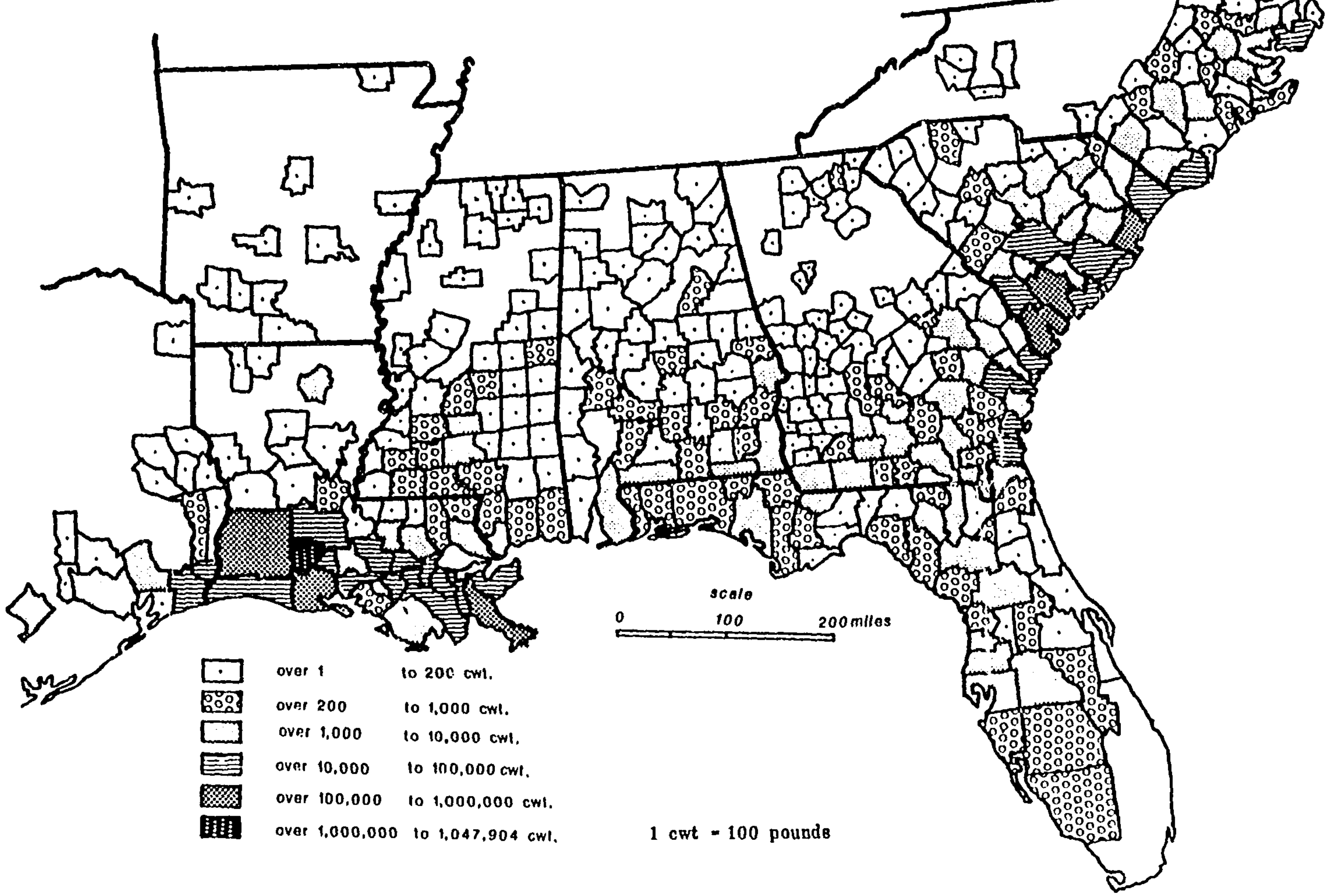


Figure II-5. Rice (Rough Rice) Production in the South in 1919 (Based on: the 1920 Census of Agriculture).

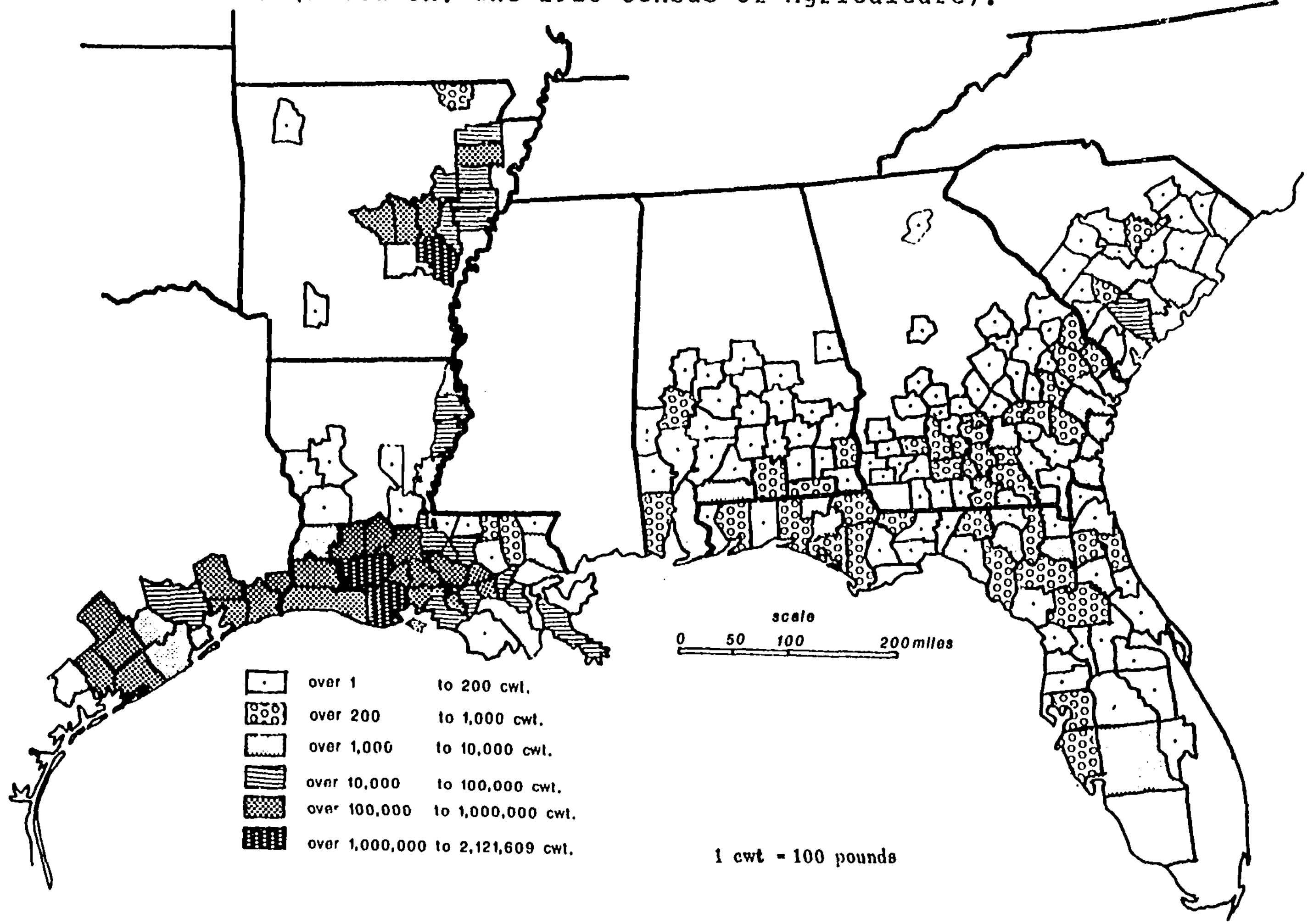


Figure II-6. Rice (Rough Rice) Production in the South in 1939 (Based on: the 1940 Census of Agriculture).

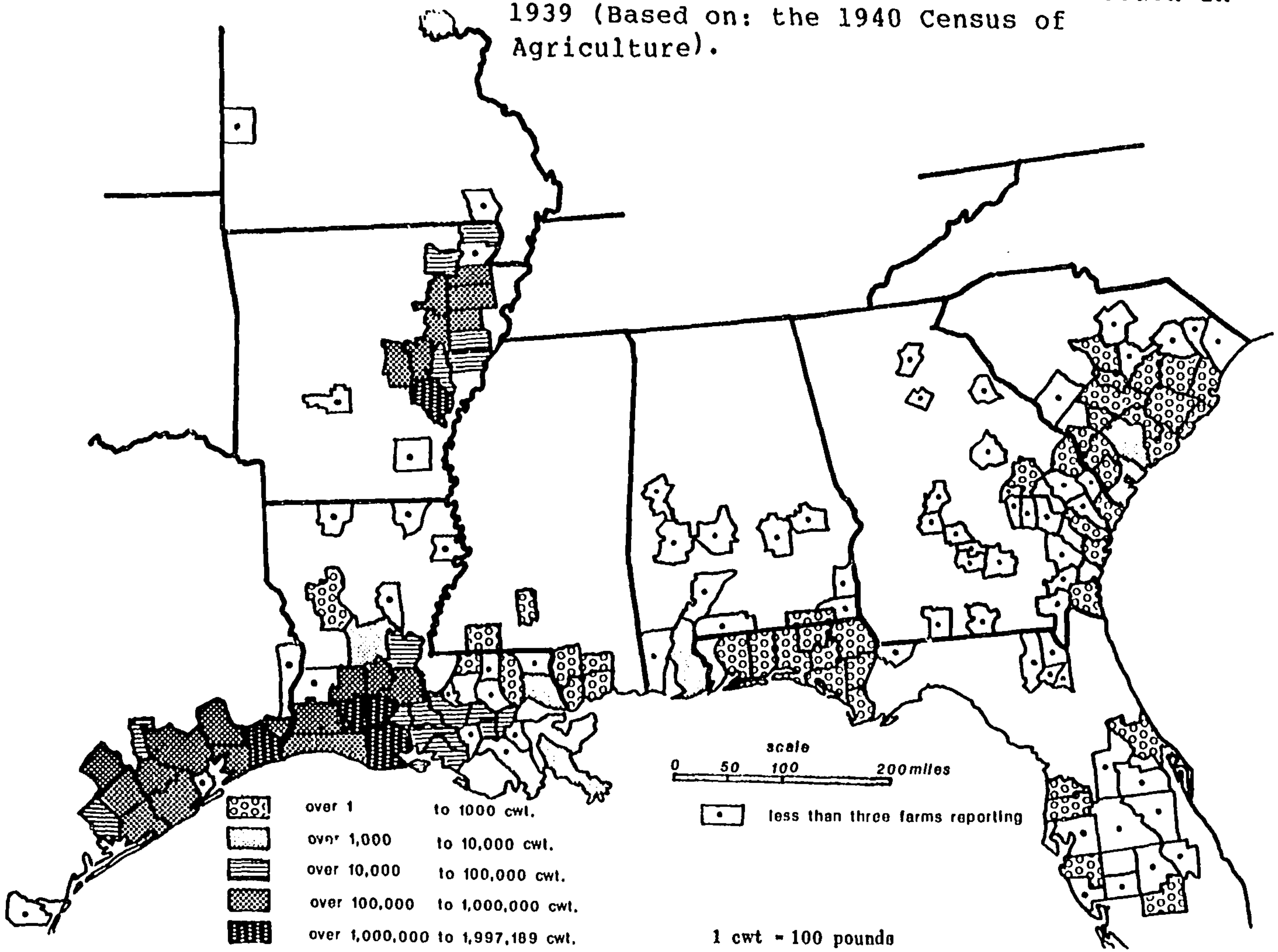


Figure II-7. Rice (Rough Rice) Production in the South in 1959 (Based on: the 1960 Census of Agriculture).

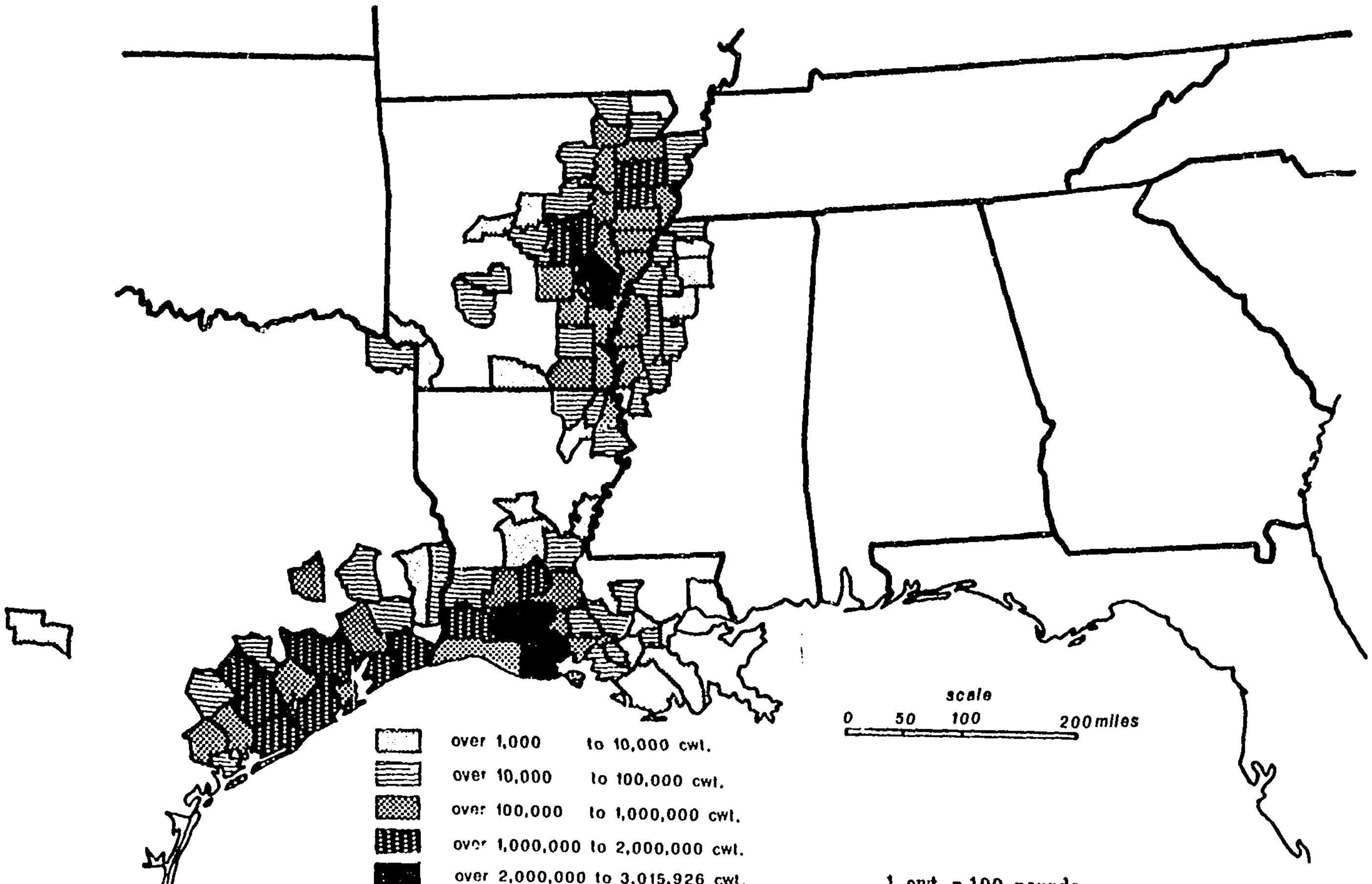
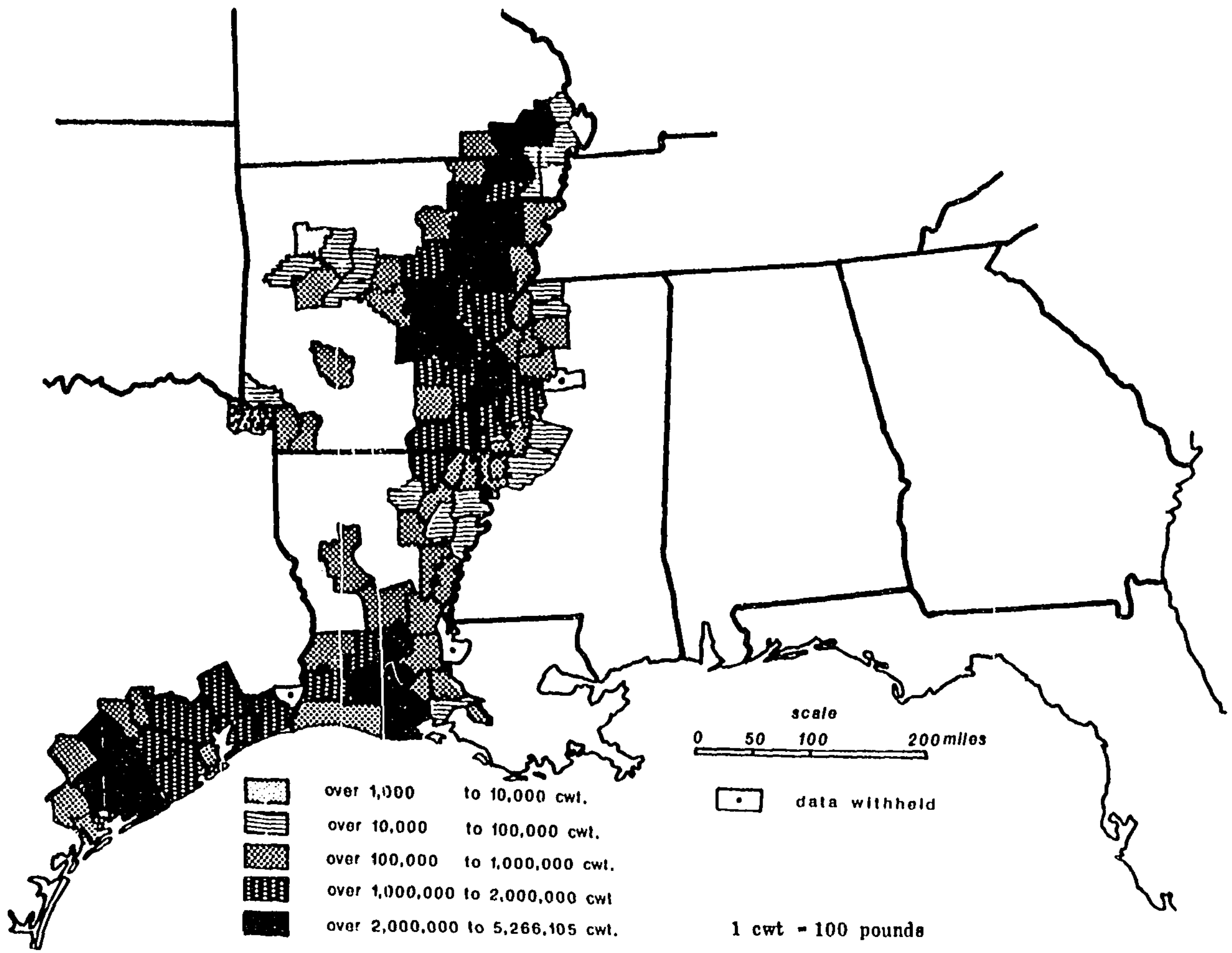


Figure II-8. Rice (Rough Rice) Production in the South in 1982 (Based on: the 1982 Census of Agriculture).



B) Gulf Coast Prairies

B-1) Southwestern Louisiana

The prairies in southwestern Louisiana are flat. Their soils are largely derived from the alluvial soils deposited as terraces during the Pleistocene Epoch of the Quaternary Period. The development of the claypan, locally called "hardpan," is the most characteristic phenomenon of the prairie soils in southwestern Louisiana. The hardpan results from closeness of the fine particles transferred from the upper horizon into the subsoil by downward percolation, which has occurred largely because of the flatness of the area and the associated poor drainage (Post 1940, p. 575). Holocene alluviums are found only along the banks of the bayous and rivers. The elongated and somewhat elevated banks are less clayey and more fertile than the larger interfluvial areas. The galeria forests often followed these banks. The Cajuns[5] often settled on such banks or on the bluffland along the river floodplains (Post 1940, pp. 575-578).

Southwestern Louisiana was late in becoming settled and as late as 1880 the Cajuns had filled only the better areas

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5 The Cajuns were descendants of the Acadians, who were expelled from Nova Scotia and came to Louisiana beginning in the 1760s. Many of them settled in southwestern Louisiana. The Cajuns were engaged in subsistence farming, fishing and hunting, and cattle raising when a flood of Midwesterners immigrated there in the 1880s.

of southwestern Louisiana, leaving large parts of the prairies virtually unsettled. A major reason for the sparse settlement was its isolation, which was broken only when railroads began to penetrate. The Southern Pacific Railroad constructed a line through southwestern Louisiana in 1882, offering an outlet for goods, and the area quickly attracted interest. In May 1883, Jabez B. Watkins,[6] a banker and land speculator, after having organized the Watkins Syndicate, bought from the state and federal governments more than 1.5 million acres of land stretching from Vermillion Parish to the Sabine River. Two thirds of this land, or one million acres, was marshland, and the remainder was in the prairies. The newly completed Southern Pacific Railroad ran along the northern edge of the Syndicate's domain. Watkins originally planned to reclaim the marshland with a grandiose scheme, but he soon turned attention to the development of the prairies. He brought Dr. Seaman A. Knapp,[7] an agricultural

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6 J. B. Watkins had had considerable success in real estate loans in Kansas and was looking for a new land where he could apply his talents. After an extensive search in 1883, he chose the southwest Louisiana for a promising site for a land development. He formed a partnership with English investors, and formed separate corporations which together were known as Watkins Syndicate. As general manager in America, he planned and managed the enterprise for the development of southwestern Louisiana (Phillips 1951, pp. 92-93).

7 Seaman A. Knapp was a former professor and then president of Iowa State College at Ames. Watkins offered Knapp a salary considerably larger than he had received as president at Ames (Bailey 1945, p. 115). S. A. Knapp and his family moved to Lake Charles, Louisiana, in November 1885. For more information, see Seaman A. Knapp:

specialist, to Louisiana with the express purpose of developing the prairies (Phillips 1951, p. 93).

After the railroad line was established, settlers began coming to the southwestern Louisiana in small numbers. The new settlers came from the Midwest, mostly from Illinois, but also from Michigan, Iowa, Indiana, Kansas, Nebraska, Minnesota, Missouri, and the Dakotas (R.J. 4 [12], p. 4; Ginn 1940, pp. 18-20).

The small number of Cajuns were already growing rice on the prairies when Knapp began his work, but the Midwestern settlers were the first to cultivate rice on a large-scale, commercial basis using modern machinery. Most of the Midwesterners were former wheat farmers, and they brought with them the tools and machinery of large-scale, prairie agriculture. They acquired land from state or federal governments and from land speculators. The Midwesterners found that their own farm machinery was well applied to the rice culture, since the prairie land was easily drained and could support the heavy machinery. Gang plow, disc harrow, drill, and broadcast seeder were included in the machinery brought to Louisiana by the Midwesterners (R.J. 10 [11], p. 263; Phillips 1951, p. 95).

S. L. Cary came from Iowa in the early 1880s and settled on the prairies of southwestern Louisiana. He

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Schoolmaster of American Agriculture (Bailey 1945).

became a state agent and recruited many immigrants from the Midwest to southwestern Louisiana (Ginn 1940, pp. 18-19):

> [Cary] passed through Louisiana and secured a book... and this work impressed him favorably with possibilities of the state. He disembarked at Jennings where the prairie reminded him of Iowa. He was surprised to find cattle grazing there on winter grass.... There was a great quantity of government land.... He returned to Jennings, found the position of station agent vacant and received the appointment. In his spare time he wrote letters to his friends back in Iowa, told them of his wonderful find, and begged them to come to Jennings. He aroused interest and had many letters to answer.... For fourteen summers Mr. Cary went North and each time returned with parties of farmers from Iowa and Illinois.

As a consequence of this population influx, agriculture prospered. In 1879, the southwestern Louisiana accounted for less than 5 percent of the state rice production, but ten years later, several years after the first Midwestern farmers brought new technology to the prairies of southwestern Louisiana, the area produced 30 percent of the state's rice crop. During the years from 1889 to 1899, the prairies became the leading producer not only in Louisiana but also in the United States.

B-2) Southeastern Texas

It is not known precisely when rice culture was initiated in Texas; most likely it was introduced by settlers who migrated to the state from Louisiana. Texas produced only 1,428 cwt of rough rice in 1849, and production did not grow significantly until the last decade of the nineteenth century. Modern rice production began with the installation of a small pumping station at Beaumont in 1891. By the following year, 175 acres of rice was cultivated near Beaumont in Jefferson County (Texas Rice Research Foundation 1987, Annual Report). In 1895, rice cultivation was still confined to the farms adjacent to Beaumont in Jefferson County (R.J. 5 [3], p. 3). Jefferson and Orange counties (Figure II-9) were pioneers of commercial, mechanized rice culture in the state.

Another early area was in the prairie land along the Colorado River. The Rice Journal (4 [6], p. 2) reported in 1901:

> You ought to see the good work going on in the Colorado Valley. There is a pleasant surprise in store for those who visit the southern part of Wharton, and the northern part of Matagorda County.... 30,000 acres of prairie land plowed up and ready for seed rice, where there was only about 400 acres [of rice land] last year.

Within a few years, rice was produced in almost all of the counties in southeastern Texas. The state rice acreage expanded from 2,000 acres in 1895 to 70,000 acres in 1900. About 264,000 acres were under rice cultivation in 1910. In 1910, Jefferson County and Orange County accounted for 79 percent and 14 percent, respectively, of the state's rice production (Surface 1911, p. 502).

Dark-colored clays and clay loams prevail near the coast marshes and light-colored loams exist just north of the clay loams. Sandy loams appear in the western portion of the Texas rice belt, i.e. to the west of Houston.

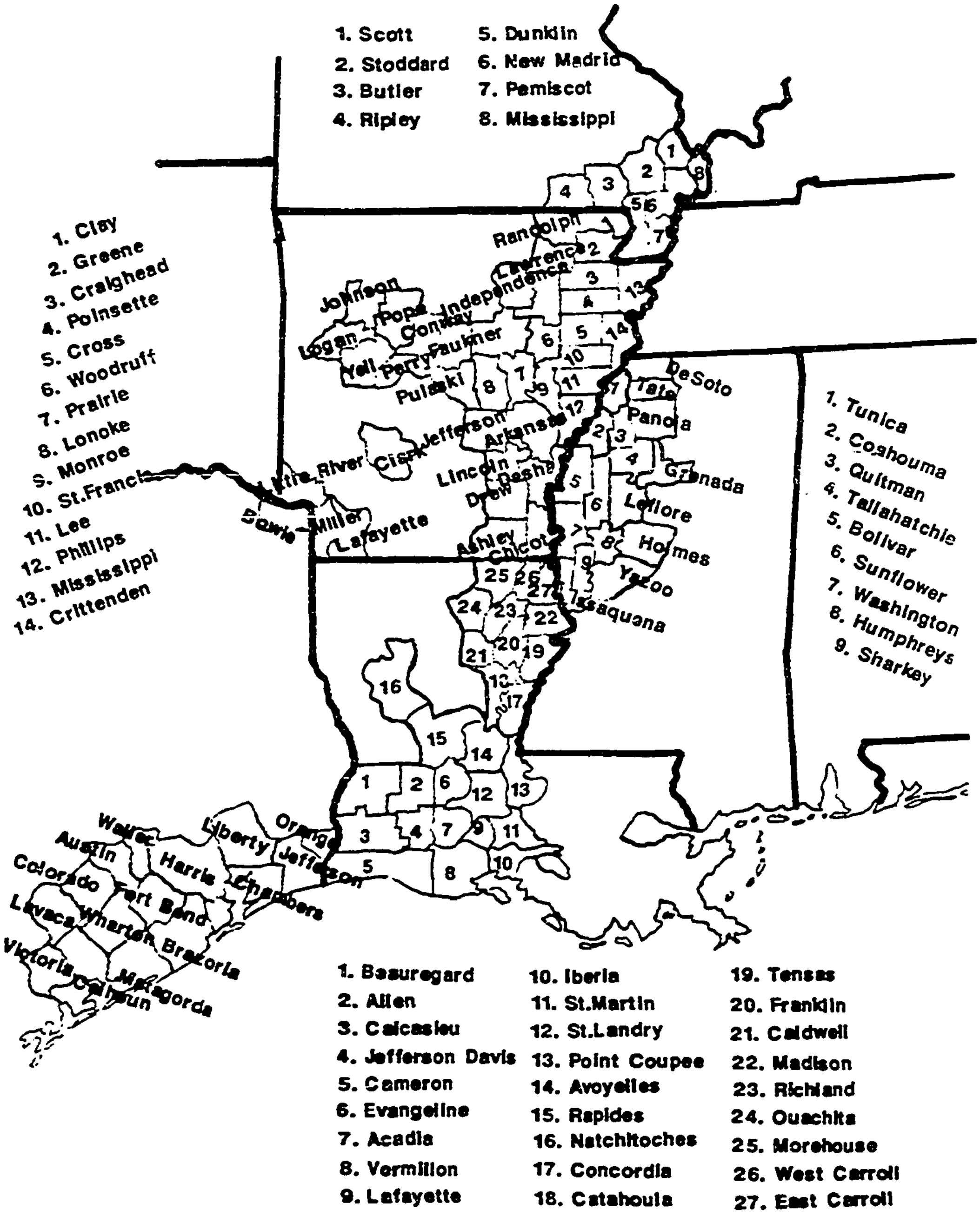

Figure II-9. Parish and County Names in the Gulf Coast Prairies and in the Lower Mississippi River Valley.

Differences in prevailing soil types between the eastern portion and the western portion of Texas rice belt necessitate many different cultivation practices in the two areas. Recently, rice-soybean rotation has become dominant in the eastern portion; rice-sorghum rotation is common in the western portion. Water-planting or broadcast planting is practiced more frequently than drill-planting in the eastern portion, but drill-planting is dominant in the west. Moreover, the rate of rice ratooning is far higher in the western portion than in the eastern.

Since World War Two, the western portion [the west side of Galveston Bay] of Texas rice belt began to produce an increasing amount of rice, compared with the eastern portion, which includes Jefferson, Orange, Liberty, and Chambers counties (Figure II-9). Recently, the core area of rice production in southeastern Texas is situated along the Colorado River, including Wharton, Colorado, and Matagorda counties (Figure II-8; Figure II-9).

C) Lower Mississippi River Valley

C-1) Floodplains and Terraces in Eastern Arkansas

Rice has been cultivated in Arkansas since the antebellum period. The U.S. Census of 1840 reported that the state produced about 88 cwt of rough rice in 1839.

Around the turn of the century, rice was grown in small patches of refuse land by blacks who came from the eastern rice-growing states (Figure II-4). Rice was also raised for animal feed by a few whites (Sibley 1902, p. 2).

The Grand Prairie, a flat land situated between the White River and the Arkansas River, became the hearth of the rice culture in Arkansas when mechanized, commercial rice culture was introduced there during the first decade of the twentieth century, and the area remains an important producer. This area has a general slope of a foot per mile from north to south, but it is broken with strips of timber along the streams in isolated bodies called islands. During the last years of the nineteenth century, some Midwesterners[8] began to settle on the Grand Prairie, which was at that time almost unoccupied. The new settlers were experimenting with various crops in this region, where cotton and corn did not grow well. Grass for forage was the main product of the prairie, and considerable quantities of this hay were cut and shipped to market. Cattle raising was also an important industry (Sampson 1955, pp. 32-37; Prince 1929, p. 26).

William H. Fuller introduced commercial rice culture into the Grand Prairie. He took a hunting trip in 1896 and

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8 According to a survey conducted in 1930 by T. C. McCormick, over 60 percent of the farmers in the rice-growing counties came from Illinois, Iowa, Indiana, and Ohio (Dethloff 1970, p. 72).

crossed the rice-growing belt in Louisiana, where he spent some time at the farms of the Abbot brothers and W. W. Duson. He returned with a small sack of rice seed and with some knowledge of rice cultivation, and he planted three acres of rice on his Grand Prairie farm in 1897. His first crop failed because he was unfamiliar with appropriate irrigation techniques. He did not give up then, but went to Crowley, Louisiana, to learn about rice growing. Engaging himself in rice cultivation, he stayed there for four years. He learned how to grow rice, put down wells, and operate farm machinery. In the fall of 1903, he returned to Arkansas and struck a bargain to raise a crop of rice on 70 acres of land and produce not less than 35 bushels per acre. He bought rice seed and machinery in Louisiana. In 1904, he planted 70 acres of rice and produced 5,225 bushels [2,351 cwt] of rough rice. As he yielded almost 75 bushels per acre from the appointed acres, he claimed the bonus, one-thousand dollars (Daniel 1985, pp. 46-48; R.J. 13 [3], p. 35; R.J. 26 [9], p. 23; Dethloff 1970, p.73).

Meanwhile, rice cultivation was undertaken by others on the Grand Prairie.[9] In 1904, a University of Arkansas Experiment Station experiment yielded 65 bushels [29.25 cwt] of rough rice per acre from 160-acre plot of virgin prairie

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9 In 1902, William Fuller's brother-in-law, John Morris, raised 320 bushels [136 cwt] of rough rice there. After Morris died in March 1903, his wife continued to work on rice cultivation.

land (Daniel 1985, pp. 46-48; R.J. 13 [3], p. 35; R.J. 26 [9], p. 23; Dethloff 1970, p.73).

The Grand Prairie proved to be well suited to rice culture, and soon rice culture spread throughout the region. The soil characteristics of the Grand Prairie are similar to those of the prairies of southwestern Louisiana. The surface soil is silty loam, from a few inches to two feet deep, underlain with an impervious clay subsoil, locally called "hardpan." The hardpan of the prairie limits permeability and slows percolation of irrigation water. Below the prairie a blue clay is reached at a depth of about 120 and 150 feet, and above this clay is located a water-bearing sand and gravel stratum. The water-bearing stratum, twenty to forty feet thick, has provided irrigation water to most of the rice fields in the Grand Prairie (R.J. 12 [12], p. 265; R.J. 20 [4], p. 28).

By 1910, cleared timber land in many parts of Arkansas had been planted with rice, and the rice belt of the state had extended northward to the Missouri border. In 1928, the Arkansas rice acreage was 164,500 acres, of which about 80 percent (131,000 acres) lay within the Grand Prairie (Figure II-5; Figure II-6; R.J. 13 [5], pp. 1-4; R.J. 33 [2], p. 18). By 1973, the three counties of Arkansas, Prairie, and Lonoke on the Grand Prairie (Figure II-9), producing 930.5 million cwt of rough rice [36.4 percent of the state total], were still the leading producers in Arkansas, even though the relative importance of the Grand Prairie decreased as rice was produced in more and more counties in eastern Arkansas (Figure II-5; Figure II-6; Figure II-7). In 1974, when the U.S. Department of Agriculture lifted marketing quota restrictions (see Chapter VIII), the rice acreage in northeastern Arkansas increased dramatically. Since then, northeastern Arkansas has accounted for more than 50 percent of the state rice production (Figure II-8).

A small amount of commercial rice was produced after World War Two along the Red River Valley in southwestern parts of Arkansas and the northeastern tip of Texas. By 1982, about 686,100 cwt of rough rice was produced in the three counties of Lafayette, Miller, and Little River of southwestern Arkansas and Bowie County of northeastern Texas (Figure II-7; Figure II-8; Figure II-9).

C-2) Yazoo Basin in Mississippi

Rice has been grown in Mississippi since the antebellum period. The U.S. Census reported that the state produced 12,581 cwt of rough rice in 1839 and 44,027 cwt of rough rice in 1849 (Appendix II). During the postbellum period, small quantities of rice were produced in almost all the counties of the state (Figure II-3; Figure II-4). Cultivation was most extensive along the Gulf Coast of the state and ironically was the least in the Yazoo Basin. Rice gradually disappeared from the state during the early decades of this century.

In 1947, Rex L. Kimbriel, Malcolm James, and Frank P. Unkel, three cotton farmers, formed a partnership for the purpose of producing rice in the Yazoo Basin. In 1948, they produced rice on a large-scale, commercial basis for the first time in Mississippi (Kimbriel 1987, p. 3). For the first several years, the Mississippi rice increased dramatically. In 1949, the rice acreage of the state was only about 5,000 acres; in 1950, 7,000 acres; in 1951, 27,000 acres; in 1952, 48,000 acres; in 1953, 53,000 acres; and in 1954, 77,000 acres. More than a fifteen-fold increase for six years! But during the following years from 1955 to 1973, the Mississippi rice industry, hampered by acreage allotments and marketing quota restrictions (see Chapter VIII), did not grow significantly. The rice acreage of the state, however, increased again dramatically after 1974, when the rice marketing quota restrictions were lifted (Figure II-10; Appendix III; Appendix IV). During the years from 1980 to 1985, the state accounted for about 7 percent of U.S. production.

In the past, irrigation water for rice cultivation in the Yazoo Basin has come either from wells or from surface water. Recently, rice farmers have become concerned with the lowering of ground water table. Wildlife conservation legislation prohibits rice farmers from drawing irrigation

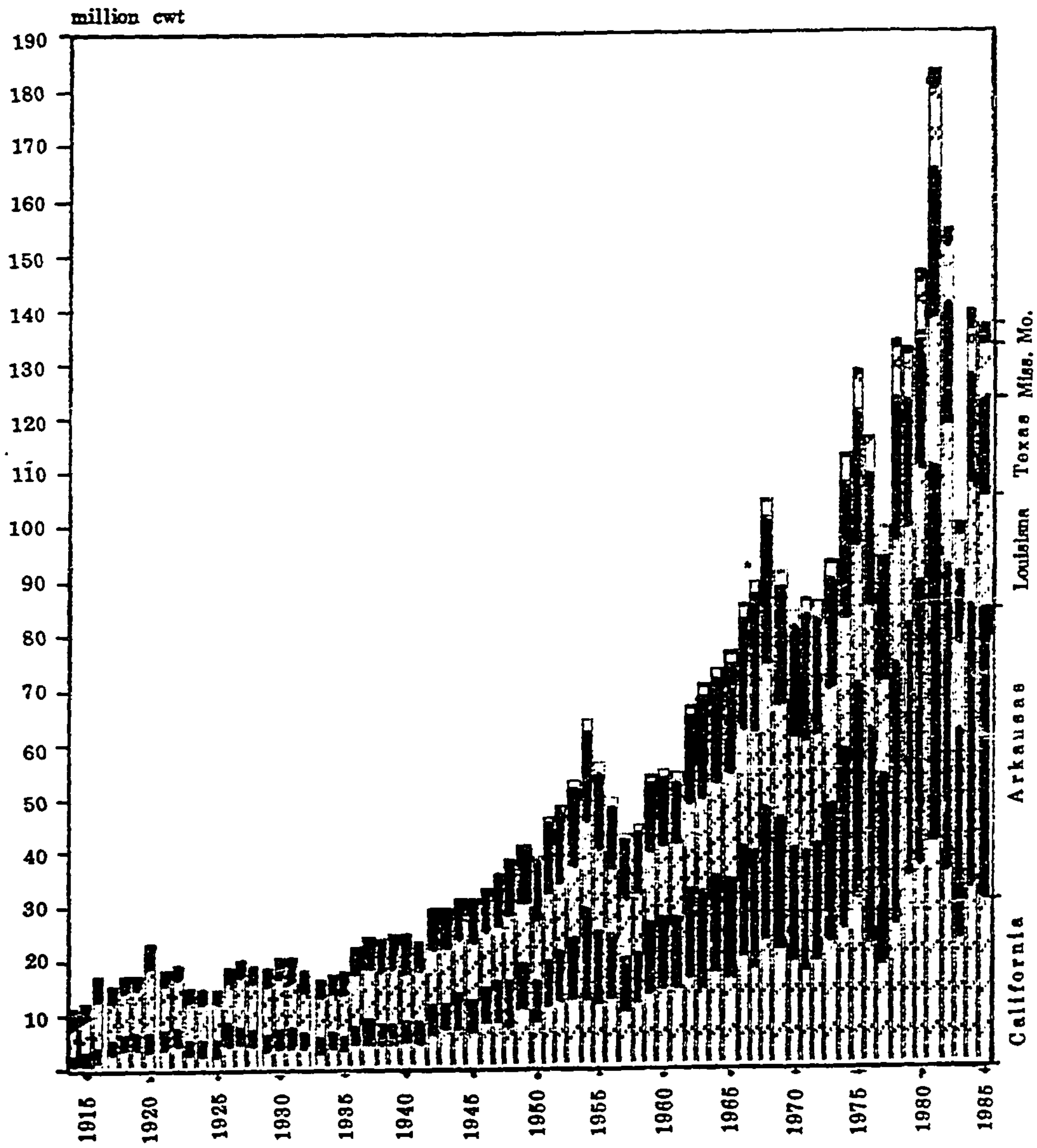

Figure II-10. Rice (Rough Rice) Production in the United States, 1914-1985 (Agricultural Statistics of the U.S. Department of Agriculture).

water from some of the streams nearby. As an alternative method, drawing water from the Mississippi River is being considered, but this may be too costly under present economic conditions. Bolivar, Washington, Sunflower, and Leflore counties in the Yazoo Basin have been responsible for most of the rice production in the state (Figure II-8; Figure II-9), and Greenville is the central city of the rice-growing area of the state.

C-3) Northeastern Louisiana

Rice was grown in northeastern Louisiana earlier than in the Mississippi Yazoo Basin and in southeastern Missouri. Here much land which had been formerly devoted to cotton growing was sown with rice in the 1910s when the boll weevil attacked cotton. Irrigation was much the same as in the Gulf Coast Prairies and in the Grand Prairie of Arkansas. Irrigation water was pumped from wells or drawn from rivers, bayous, and the lakes nearby.

Much of the rice land was returned to cotton fields after boll weevil infestation diminished, and in the 1950s northeastern Louisiana accounted for only about 1 percent of the state's rice acreage. During the years from 1961 to 1973, rice acreage in northeastern Louisiana increased slightly but was relatively static at about 3 percent of the state's rice acreage. However, the area has shown a remarkable vitality after 1974, the year when marketing quota restrictions were lifted. In 1975, all the eleven parishes in northeastern Louisiana produced rice, the rice crop produced there amounting to 8.9 percent of the state production. Since the mid-1970s, this percentage has increased gradually. In the early 1980s, northeastern Louisiana accounted for about 20 percent of the state rice production.

C-4) Southeastern Missouri

The potential for the commercial rice production in southeastern Missouri was known as early as the 1910s. In 1914, George Begley, Jr., harvested rice on the 139 acres of land in Popular Bluff, Missouri (R.J. 19 [3], pp. 15-16; R.J. 20 [5], p. 34). In 1920, D. E. Demange harvested rice with an average of about 55.5 bushels [25 cwt] of rough rice per acre from the 200 acres of land in Stoddard County, Missouri (R.J. 24 [3], p. 34; Figure II-9).

In 1923, an experimental crop of rice on 14.5 acres of land on Alvin V. Rowe's farm near Elsberry, Missouri, yielded an average of 98 bushels [44.1 cwt] of rough rice per acre (R.J. 27 [1], p. 14). The following year, Mr. Rowe increased his acreage. A few neighbors also followed his example and planted rice (R.J. 30 [4], p. 20). The rice growers there found soon that the well water of the district was too cold to be used for rice irrigation10 (Daniel 1985, p. 58). In 1925, the rice acreage of the district was more than doubled and several pumping plants were installed along the Mississippi River (R.J. 30 [4], p. 20). In 1926, about 9,000 acres of land was planted with rice in the Elsberry district, and 400,000 bushels [180,000 cwt] of rough rice [an average of 20 cwt of rough rice per acre] was harvested (R.J. 29 [11], p. 11). However, rice production disappeared in the Elsberry district probably because the disadvantages of the boggy swampy soils and the flooding danger in this area.

Despite the potential of rice culture in Missouri, it was not until 1954, when 212,000 cwt of rough rice was produced in Missouri, that the state emerged as a major producer. W. L. Duncan and his brother-in-law, George Norwood, began to grow rice on white buckshot soil near Poplar Bluff in 1954. The buckshot soil of the area, comprised of a mixed loam with equal amounts of sand and clay, holds water well. In early 1979, Duncan and Norwood, who had grown rice for twenty-four consecutive years on the land, praised the soil fertility (R.F.[11] January 1979, p. 14):

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10 Cold water pumped from wells may retard the growth of rice plants. If well water is too cold, farmers have to depend on surface water or operate reservoirs to reserve the well water for some time before used as irrigation water.

11 R.F. represents the Rice Farming magazine in this dissertation (Appendix V).

> The soil fertility on our farm is better now than it was when we first started rice farming. There is a layer of solid white limestone under the ground that gives our fertility programs a boost by breaking up the fertilizer.

Since 1954, rice production has increased continuously in southeastern Missouri. The state rice acreage increased dramatically after 1974, the year when marketing quota restrictions were lifted (see Chapter VIII). Recently (during the six years from 1980 to 1985), Missouri has accounted for about 2.2 percent of the U.S. rice crop (Figure II-8; Figure II-10; Appendix III).

CHAPTER III

WATER SUPPLY AND MANAGEMENT IN RICE CULTIVATION

A) Historical Methods

A-1) Tidewater Irrigation in the South Atlantic Hearth

During the experimental stage of rice culture in South Carolina, rice was grown on upland sites or on isolated areas of low ground without artificial irrigation. As it became clear that rice was suited better to moist soil, inland swamp land was cleared for extending rice fields. Across the upstream and downstream margins of the fields were usually built earthen dams, which controlled the irrigation water on the rice fields through wooden sluice gates (Figure III-1). When the rice fields became too grassy to be planted with rice, alternate inland swamp lands were cleared for new rice fields. Through time rice fields gradually were moved to the larger swamplands or marshlands along the lower rivers near the coast, and a more sophisticated tidewater irrigation method developed. The tidewater irrigation method began to appear before the Revolutionary War. It co-existed with the inland swamp irrigation method for some decades, and then became the

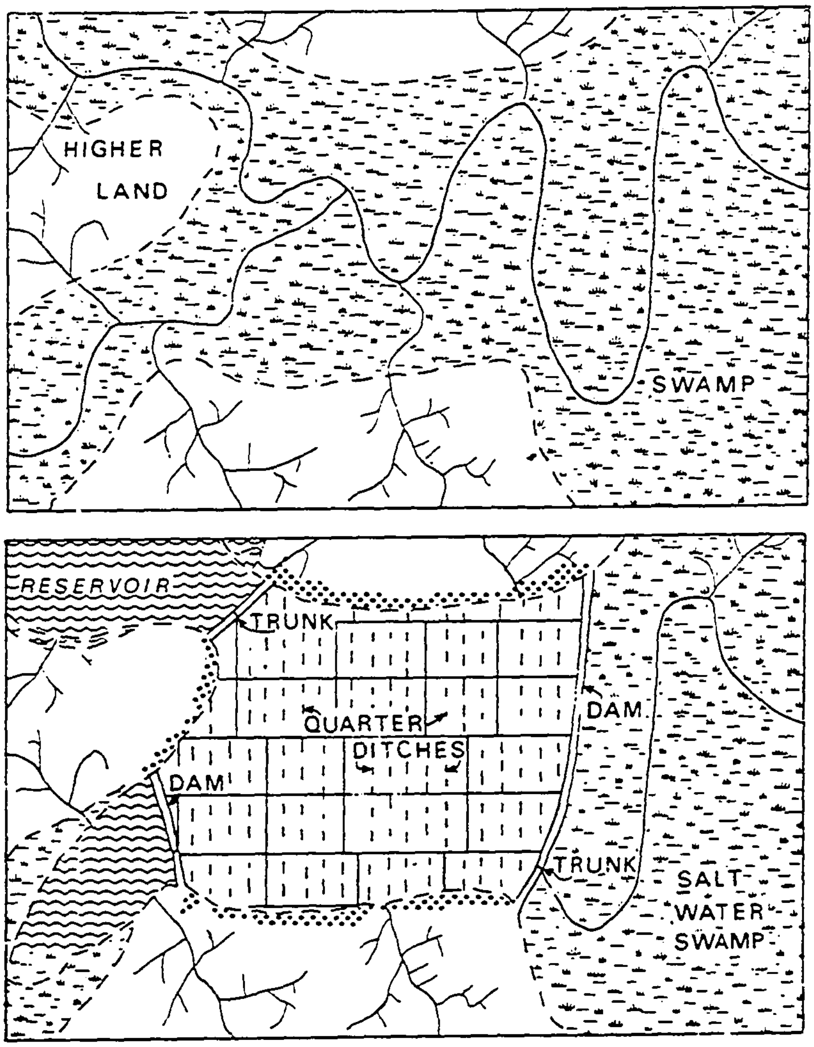

Figure III-1. Hypothetical Development of an Inland Swamp Rice Field (Noble 1956, p. 14).

dominant irrigation method in the South Atlantic Hearth (Hilliard 1978, p. 94; Lee 1960, p. 81; Efferson 1952, p. 410; Wilms 1972, pp. 49-51).

Appropriate sites for the use of tidewater irrigation were the alluvial lands which, before they were reclaimed, were flooded at each tide with fresh water to a depth of two or three feet (Figure III-2). To reclaim the alluvial lands, dikes [permanent embankments] or dams were constructed parallel to the rivers. The dikes were usually 12 to 25 feet thick at the base, and 5 to 10 feet high. Check banks [cross-banks] or dams divided the rice field into sections [inclosures] of 5 to 30 acres, and ditches subdivided these sections into beds. One wooden trunk in each section connected the rice field with the stream (Figure III-2; Figure III-3). An inner door and an outer door operated at each side of the trunk. When the rice fields were to be flooded, the outer door was opened. Then, as the tide from the ocean entering the rivers caused the water level of the rivers to rise, the water of the river flowed into the rice fields through the trunks and through ditches. When the rice fields were to be drained, the inner door was opened (Figure III-3). The tidewater irrigation was characteristic of the rice culture of the South Atlantic Hearth, but was never reported in any other rice-growing areas in the United States (Hilliard 1978, pp. 91-115; Gray 1958, pp. 721-731; the U.S. Census of Agriculture 1900, p.

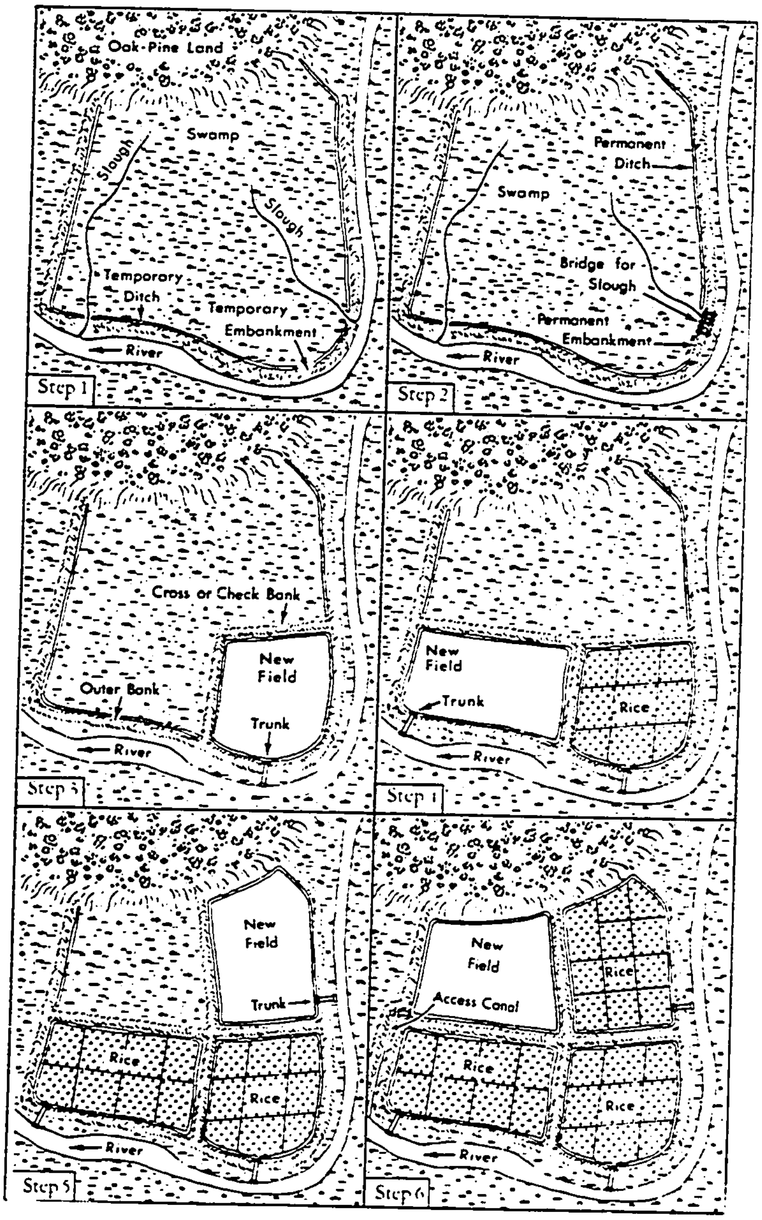

Figure III-2. Hypothetical Plats of the Developments of Tidewater Rice Fields (Hilliard 1978, p. 106).

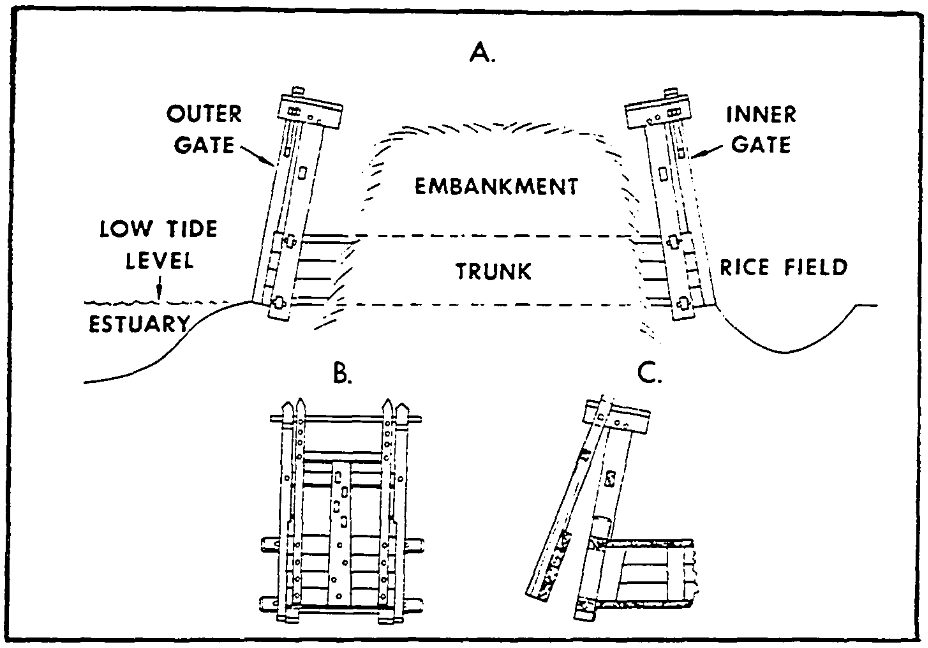

Figure III-3. Cross-section of a Trunk and Detail of Gates (Hilliard 1978, p. 108).

53; Allston 1846, pp. 333-338).

A-2) River Rice in Southern Louisiana

In occasional years with abundant rainfall, rice was cultivated without artificial irrigation in southern Louisiana along the Mississippi River, but most years the rice fields were irrigated by using a variety of methods. Moreover, the irrigation method of the rice fields changed through time. Wilkinson (1848, pp. 53-57) mentioned the irrigation method of the antebellum river rice:

> The common system of rice planting here [Plaquemines, La.] is to begin in February to dig out the ditches, which, in a farm of four acres front on the river, consists of one ditch four feet wide or more, four to five feet deep, running from the river to swamp, with a dam or gate behind, at right angles, to this main ditch. At every half-acre is a two-foot cross ditch, with a bank behind it to confine the water about a foot high or more. At the back of the field is a four-foot ditch running parallel with the river, with a high bank on the outside to completely dam in the field, with a flood-gate opening behind to gauge the height of water.

The irrigation method of the antebellum river rice was referred to again in DeBow's Review (1856, p. 290):

> During the ordinary stage of the river, from March until July, they can be flooded to a depth of from several inches to several feet, by merely cutting the levee and letting the water run in [through the levee-cut], and when the river is lowest, they may be effectually flooded by machines [steam-power engines], such as are in use on most all of the large sugar estates.

As settlement along the river intensified, a system of artificial river levees were constructed to prevent overflow from the river. Along the Mississippi River in southern

Louisiana, the levees probably averaged forty feet thick at the base, eight feet high, and six feet wide at the crown. During flood stage in spring, it was easy to divert flood-water through channels onto rice fields. Even after the rice was planted, the water level of the river remained somewhat above that of the rice fields. During the rice-growing season, rarely did the water level of the river fall more than two or three feet below the surface of the best rice lands on the Lower Mississippi River Delta (DeBow's Review 1856, p. 290). The water level often rose from two to four feet above the surface of rice lands, making it possible to irrigate rice fields by gravity (The U.S. Census of Agriculture 1900, p. 53).

The simplest way to draw water from the rivers was a levee-cut through which water gravitated from the river directly into the main ditch without sophisticated implements. However, this method was possible only when the river rose to levels higher than the elevation of the main-ditch's entrance. The sluice-gates and flumes were constructed in the river levees much in the same way as the trunks in the dikes of the tidewater irrigation system used in the South Atlantic Hearth. With an increase in flood menace resulting from the breaks in the levees, the levee-cuts and the sluice-gates gradually were replaced with more complicated water-lifting systems (The U.S. Census of Agriculture 1900, p.55; Lee 1960, p. 148 and pp. 168-178).

During periods of low water, it became necessary to find ways of lifting water out of the river. During the antebellum period, small water wheels were used, six or eight feet in diameter, and powered by two horses or mules. Steam power began to replace animal power toward the end of the antebellum period, especially on the larger enterprises (Wilkinson 1854, pp. 535-538). Water-lifting devices improved considerably during the postbellum period, especially after 1890 when the legal code prohibited any type of boxed flumes or pipes inserted through the banks, and so the number of water-lifting devices increased rapidly, reaching a peak during the last decade of the nineteenth century. River rice in southern Louisiana diminished gradually after the turn of the century, and had almost disappeared by the late 1950s when Chan Lee studied the last relicts of irrigation devices of river rice in southern Louisiana (Lee 1960, pp. 169-200).

A-3) Providence Rice throughout the South

Small-scale rice cultivated without systematic or artificial irrigation, so-called providence rice, presumably named because of a dependence upon "Providence" for water, was widely produced in the South (Figure II-3; Figure II-4; Figure II-5). In fact, the first rice produced in South Carolina was cultivated without irrigation. Even after systematic irrigation methods were practiced along the South

Atlantic Hearth and later along the Lower Mississippi River, providence rice continued to be cultivated throughout the South. The cultural practice of providence rice noticeably declined only after large-scale, commercial rice production emerged at the end of the nineteenth century. But the practice continued until very recent time at a very modest level. In 1956, Chan Lee (1960, p. 109) found that providence rice was still raised on the lower parts of Bayou du Large, Terrebonne Parish in Louisiana.

The cultural practices of providence rice varied from place to place in the South. Upland dry rice was cultivated in a similar fashion to wheat or oats. The Cajuns in southwestern Louisiana cultivated rice by broadcasting rice seed on the marais, i.e., small ponds. Providence rice was often inundated during the rainy season. Compared with the commercial rice culture of the South Atlantic Hearth and of the southern Louisiana along the Lower Mississippi River, the providence rice was grown on a small-scale basis, primarily for home consumption. It was never very profitable in the South as a commercial venture.

B) Water-lifting and Canal Irrigation

In southwestern Louisiana, rivers and bayous could supply an enormous quantity of water for the irrigation of rice fields. Unfortunately, the water, being fifteen to thirty feet below ground level, could not be carried by gravity, hence the necessity of water-lifting devices (Crippen 1901, p. 1). The first successful lifting of water occurred in 1885 through the use of steam pump (Ginn 1948, p. 26). David Abott used a steam engine to raise water from a bayou for the irrigation of his nineteen-acre rice field in 1888, and with improved machinery he irrigated 100 acres in the following year (Daniel 1985, pp. 42-43).

In 1890, C. C. Duson of Crowley erected a vacuum-pump plant to furnish water from Bayou Plaquemine, two miles northeast of Crowley, to planters at a fixed rate per acre. In 1892, various makes of pumps were advertized and used for pumping water on the rice fields in southwestern Louisiana (Ginn 1940, pp. 26-27). In 1894, the firm of W. W. Duson & Bro. operated a Huffer pump on Bayou Plaquemine. However, the Huffer pump, powered by condensing steam, was not very successful because local water was too warm. Crippen (1901, p. 2) explained:

> ...a vacuum pump known as the Huffer pump, built [first] in Colorado [state]. The pump consisted of two cylinders holding 100 gallons each, fastened to an iron bed plate resting on top of the suction pipe. ...steam simply being allowed to enter each cylinder, when a spray of cold water was injected into the cylinder, which condensed the steam, thus creating a vacuum which the water rushed in to fill; the water was then discharged into a flume.... The pump was designed and built to operate in the cold mountain streams of Colorado, where...it scored a marked success. It failed, however, in southwestern Louisiana on account of the temperature of water in our streams.

A small but effective centrifugal pump was in use in 1895, and a larger centrifugal pump, which could deliver 5,000 gallons water a minute, was installed in 1896. During the following years, a number of pumping plants were installed and operated to lift water from bayous to ditches for the irrigation of rice fields in southwestern Louisiana and southeastern Texas (Adair and Engler 1955, p. 390; Daniel, pp.42-43; Ginn 1940, pp. 26-27). Though some planters used small pumps, the pumping plants could not be built at every farm because of the costly installation and because of the long distance of some farm lands from the streams.

Canals, therefore, were devised to carry and transport water long distances. In 1893, C. L. Shaw and A. D. McFarland built the first canal in southwestern Louisiana on a rice field ten miles from Jennings (Ginn 1940, p. 27). The droughts of 1894 and 1895 made more farmers turn to irrigation. By 1894, Acadia Parish had a canal network fifteen miles long with ten additional miles of laterals. By the turn of the century, the parish had nine canals totaling one-hundred and fifteen miles (Daniel 1985, p. 43). The canals were first built for the purpose of providing irrigation water to private lands, but soon the owners extended the capacity of their pumping plants to supply water to the rice fields of their neighbors. Water was pumped from the streams by individual rice growers or by irrigation companies, and was carried in the surface canals to rice fields (Figure III-4; Figure III-5). The main canals were usually very wide and deep, for in most cases they were intended to function partly as reservoirs (R.J. 8 [3], pp. 2-3).

The canals were built by throwing up two levees with the dirt all being taken from the outside of the canals, and so the canal base was usually as high as the ground level of nearby fields. The two levees were from fifty to two hundred feet apart, and from four to ten feet high; the base of each levee was from twelve to twenty feet wide; the crown of each levee was about five feet wide. Where canals encountered deep gullies or small streams, wooden flumes instead of earthen canals carried water. The water carried by main canals was distributed by laterals over the adjacent rice fields (The U.S. Census of Agriculture 1900, p. 55; Crippens 1901, pp. 1-2).

Many canals have been phased out in favor of wells for the irrigation of rice fields during this century. Since the 1960s, underground irrigation systems have been substituted for the canal system in many parts of rice-producing areas in the South. However, the canal system still plays an important role in some rice-producing areas in the South. In Texas, the canal system is still the most important irrigation method. Canals are also found in the Grand Prairie. The writer discovered that a small seasonal

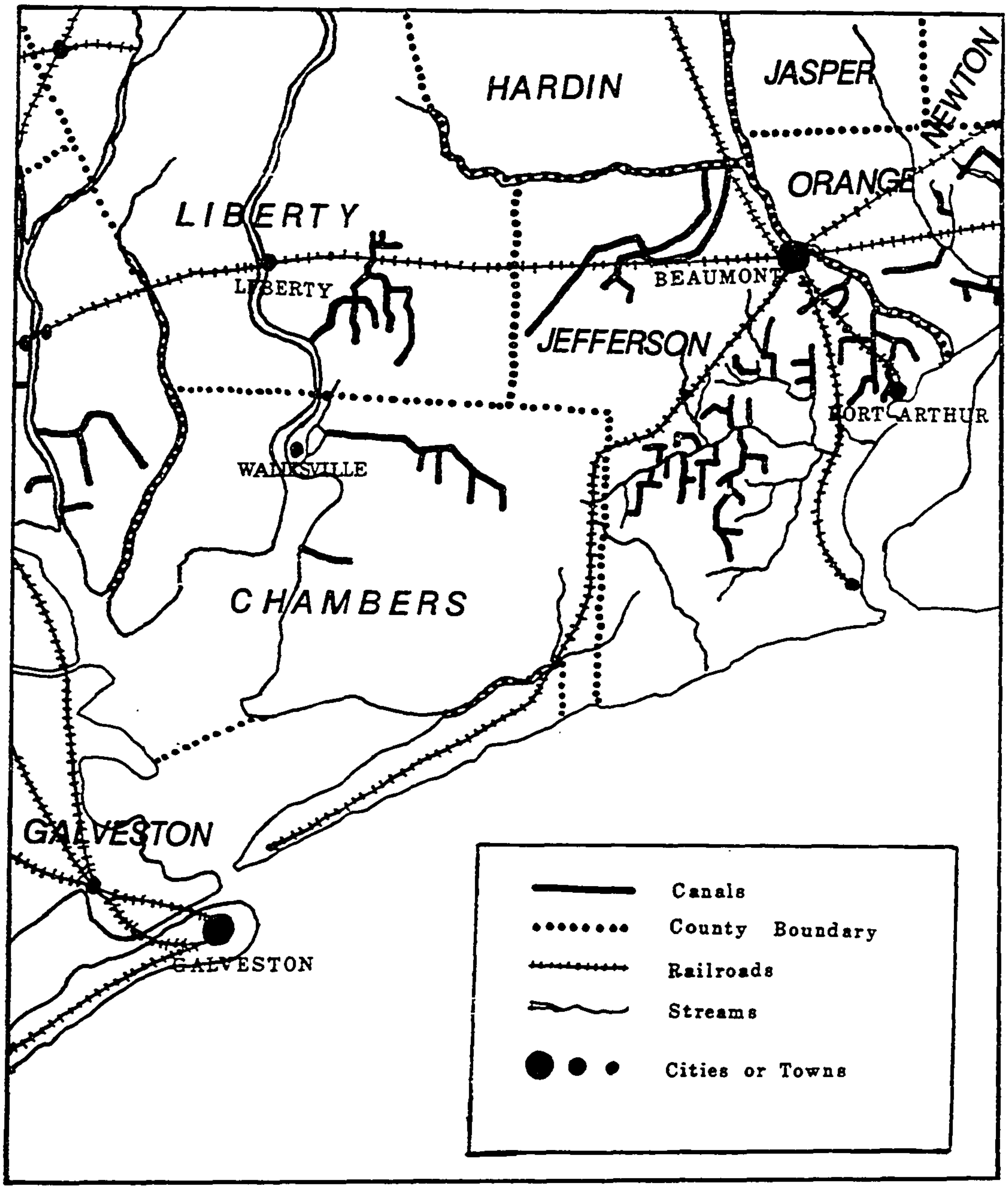

Figure III-4. Canal Map of Southeast Texas in 1902 (R.J. January 1903, p. 35).

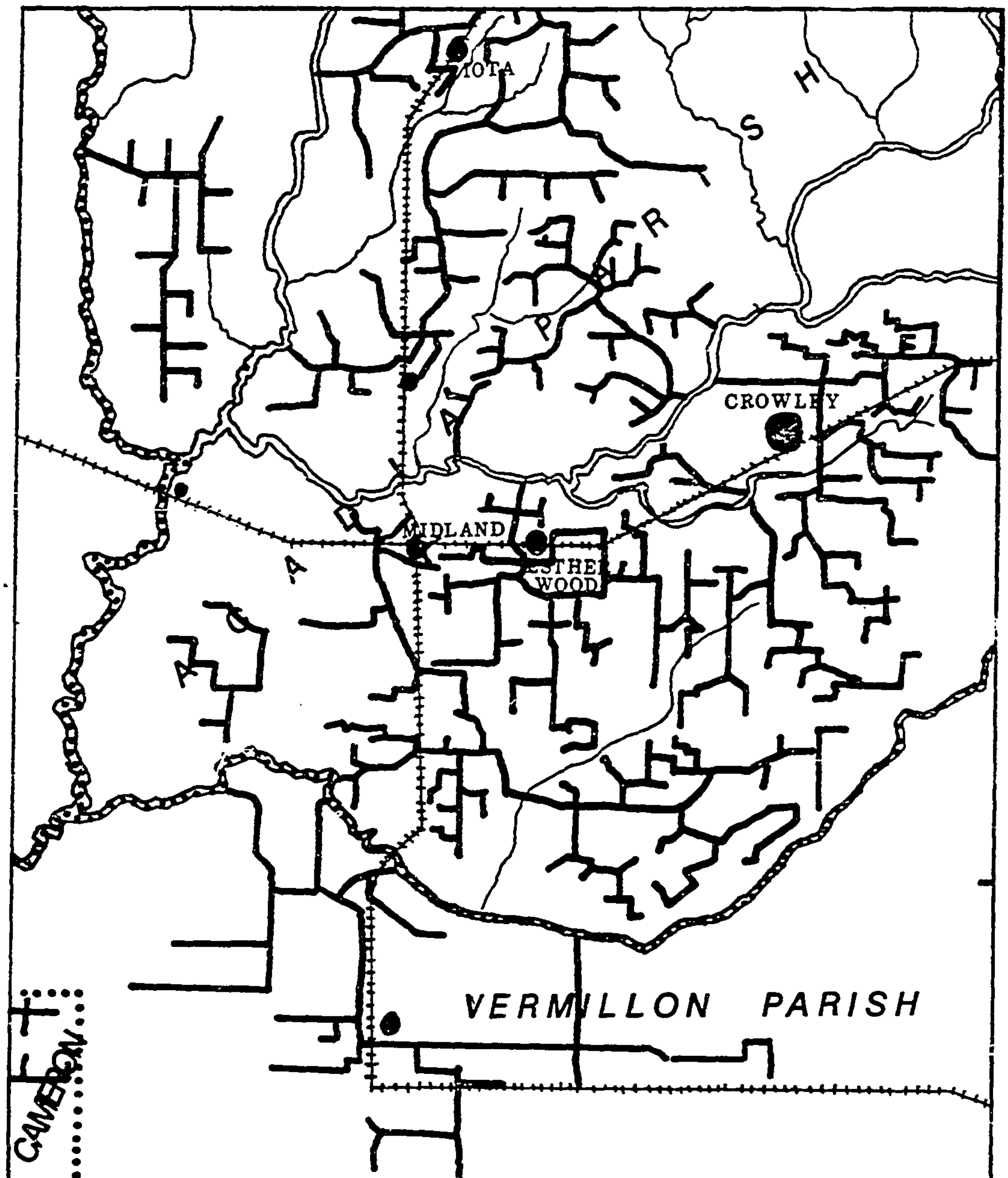

Figure III-5. Acadia Parish in 1902 (Solid Line Indicates Canals) (R.J. January, p. 430).

canal of more than one-mile length was carrying water drawn from wells to rice fields ten miles south of Stuttgart on May 31, 1988 (Figure III-6). The canal was less than six feet wide, and the water level of the canal was less than one foot high above ground. The canal base was, of course, as high as the nearby ground. In spring 1988, the Rice Experiment Station at Stuttgart was operating a large canal, the water level of which was about five feet above the ground level of nearby fields (Figure III-7). Such a large canal is able not only to carry water to rice fields but also store a huge amount of irrigation water. Thus a large canal often functions as both a water carrier and a reservoir.

C) Well Irrigation

In southwestern Louisiana, some potential rice fields on the prairies were too far from bayous to be irrigated through the canal system. In 1895, Jean Costex of Mermentau irrigated his rice fields successfully with a two-inch well driven by a wind-mill (Ginn 1940, pp. 28-29). Soon many farmers opted for the well system for irrigation, but they generally operated their well pumps by steam power, using wood as a fuel. Diesel engines began to be in common use for pumping water after 1919 (Adair and Engler 1955, p. 390). In 1929, Prince (1929, p. 26), however, observed that

Figure III-6. A Small-size Canal Is Carrying Water to Rice Fields on a Farm near Stuttgart, Arkansas (Photo Taken by the Author on May 30, 1988).

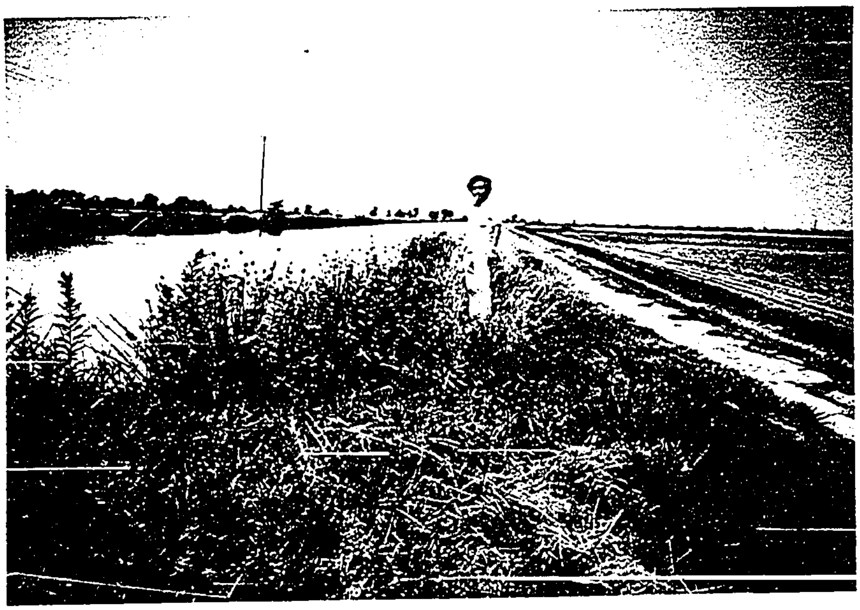

Figure III-7. A Large Canal of the Rice Experiment Station at Stuttgart in Arkansas Functions as Both a Water Carrier and a Reservoir (Photo Taken by the Author on June 1, 1988).

a few of the steam engines were still in operation in the Arkansas rice belt. During the latter half of the 1920s, electric motors were introduced in the rice fields. By 1928, 280 pumping plants among the total 1,400 wells were driven by the electric motors in the Grand Prairie (Prince 1929, p. 26), and by 1955, about 1,800 irrigation installations [a half of the total number] were powered by electricity in Arkansas (Adair and Engler 1955, p. 390). By 1955, 1,061 wells were operated in Louisiana. Among them 450 wells were powered by diesel engines; 212 wells, by natural gas; 105 wells, by electricity motors; and the remainder, by other units (Table III-1). Diesel, electricity, and natural gas are still the major power sources for the pumping plants for the irrigation of rice fields in the South.

Table III-1. Power Sources for Irrigation Wells in La. in 1955

Total Wells	Diesel Engine	Natural Gas	Electric Motors	Others
1,061 (100 %)	450 (42.41 %)	212 (19.88 %)	105 (9.89 %)	294 (27.71 %)

Source: Adair and Engler 1955, p. 390.

Water sources for irrigation has changed through time and varied among the rice-producing areas. Arkansas rice farmers have heavily depended on wells; most Texas rice farmers have relied on streams for water sources. In southwestern Louisiana, streams were the major water sources for irrigation at the beginning of this century, but since then well systems gradually have replaced the stream-canal systems (Table III-2). By 1949, probably 90 percent of Arkansas rice acreage, 40 percent of Louisiana rice acreage, and 20 percent of Texas rice acreage were irrigated by water drawn from wells (Jones and others 1952, p. 4; Adair and Engler 1955, p. 390).

Table III-2. Water Sources for Irrigation in Southwestern Louisiana in 1902 and in 1946

	1902 acres (%)	1946 acres (%)
streams alone	322,759 (83.31 %)	248,940 (47.74 %)
wells alone	48,619 (12.55 %)	243,773 (46.73 %)
streams and wells	16,050 (4.14 %)	28,786 (5.52 %)

Source: R.J. March 1947, pp. 11-14.

Well irrigation systems are usually more costly to operate than the stream-canal irrigation systems. But the differences are often offset by the following advantages of well irrigation. The well system can be efficiently operated in a smaller scale with more flexibility to field requirements than the stream-canal system, and the seed-free water drawn from wells can reduce the cost of weeding. In Arkansas, especially in the Grand Prairie, water is pumped from wells and then stored in reservoirs for irrigation of rice fields as needed. Rice farmers should consider local conditions to decide which irrigation systems are appropriate for their rice fields.

D) <u>The Quality of Water and the Ground Water Table</u>

In rice areas near the oceans, growers have had to contend with salt water intrusion. Salt water became a serious threat to the rice farmers in the Gulf Coast Prairies soon after rice culture was introduced. The mean water-levels of the rivers in the Gulf Coast Prairies were but slightly higher than sea level. During periods of peak demand, pumping plants often drew water from the rivers so heavily that water-levels of the rivers easily dropped below the sea level. Consequently, salt water flowed up the rivers, becoming a serious threat to growers at some locations in the Gulf Coast Prairies (Abbot 1904, p. 2; <u>R.J.</u> 52 [2], p. 8).

In southwestern Louisiana, excessive use of ground water has resulted in an inland movement of salt water from the coast toward the pumping areas. Although the intrusion of salt water in the principal rice fields is not a pressing danger, it is one of the concerns that should be carefully monitored (Turcan, Jr. 1965, p. 32).

Inland from the coast, other problems may be encountered. Water drawn from shallow wells in Arkansas contains a relatively high quantity of calcium and magnesium ions that increase the soil pH in the rice field. Such ions in well water can combine with fertilizers and other chemicals to form salts, inhibiting the ability of rice plants to take up fertilizers and chemicals. Moreover, the temperature of the water drawn from shallow wells in Arkansas is usually 65 degree F or lower. Such cool water may retard the development of rice plants and reduce the harvest (Adair and Engler 1955, pp. 391-192). Therefore, the continuous use of water drawn from shallow wells can cause a serious drop in rice yields in Arkansas farms. For this reason, Arkansas rice farmers have been advised not to irrigate rice fields with the water directly drawn from shallow wells; rather, it has been suggested that they use water drawn from deep wells or the surface water found in reservoirs, lakes, or streams. Occasionally, high salt contents show up in the water pumped from deep wells in Arkansas. In this case, rice farmers are limited to the use of surface water.

The demand on ground water has taken a toll. The ground-water table has been lowered almost everywhere in the southern rice-producing areas. In February 1901, the water table in a well near Welsh, Louisiana, was nearly fifteen feet above sea level. In February 1950, the water table at that point was nine feet below sea level, indicating a decline during this period about six inches per year. As the water-table declined, the well irrigation became more expensive and the water salinity of some wells near the Gulf grew too high for the well water to serve as a source of irrigation (R.J. 53 [12], p. 15). As early as the 1920s, the water-table under the Arkansas prairies had fallen sufficiently that many farmers had to turn to streams or reservoirs for irrigation water. By the early 1930s, large reservoirs were planned to be built in Arkansas prairies (Daniel 1985, p. 60).

E) Reservoirs

The alkalinity of soil can be reduced by irrigating the field with water drawn from reservoirs, for water in reservoirs generally has a lower concentration of calcium and magnesium ions than water pumped from wells. Reservoirs also permit the growers to irrigate rice fields quickly. They also have the added advantages of serving as livestock ponds, hunting sites, or fish-breeding tanks.

In Arkansas (esp. in the Grand Prairie), where irrigation water has been mostly drawn from wells, it has been recommended to rice farmers that they build more reservoirs. The first reservoir in Arkansas was completed by Verne and Arthur Tindall in 1923. The reservoir was constructed on 450 acres of timber land on the Grand Prairie. Not located on a stream, the reservoir was fed only by surface runoff and rainfall (R.J. April 1955, p.

38). In the early 1950s, a large number of reservoirs were built on the Grand Prairie to supply irrigation water for the rice crop. Most of the reservoirs were located on land that was low, undeveloped, or unsuited for rice (R.J. May 1953, p. 18; R.J. February 1955, p. 15; R.J. May 1955, p. 20).

Reservoirs in the rice-growing areas also provide good rest areas for waterfowls and therefore attract hunters. In winter,[1] some rice farmers in the South often open their reservoirs and flooded rice fields for duck hunting, claiming that their rice fields are paradises for duck hunting (refer to Chapter VI-E). In late 1976, Carlos Carter, an Arkansas County rice farmer, made $16 to $20 per acre from his reservoir and from his flooded 720-acre fields by selling hunting leases (R.F. March 1977, p. 16).

F) Dry-Planting and Water-Planting

Water-planting is distinguished from dry- or drill-planting in that the seed is broadcast on a flooded field. For water-planting, the seed is often soaked in water and

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1 The Lower Mississippi River Valley is a major waterfowl wintering area in the United States. Here are found numerous abandoned river channels, sloughs, and lakes. Many birds use the open water for resting, flying out to feed in harvested cropland (Chabreck 1987, p. 196). Eastern Arkansas has been nationally famous for its duck hunting. There are numerous fee-hunt camps and lodges along the Mississippi River and in other areas of eastern Arkansas.

pre-sprouted before being broadcast into the flooded field. In some cases, the seed is broadcast on a dry or wet field and then the field is first flooded.

In the South Atlantic Hearth, water-planting or broadcasting sowing was not known. Planting in the South Atlantic Hearth was done by applying 110 or 135 pounds of rice seed per acre, sown in furrows three inches deep, three to five inches wide, and twelve to fifteen inches apart before the first flooding. In some points of South Carolina, growers wetted the seed and located it in mud in order to make sure it did not float during the first flood and also to keep birds from feeding on it (Allston 1846, p. 331; R.J. 6 [2, Part Two], p. 38; and Gray 1933, p. 280).

In southern Louisiana along the Lower Mississippi River, on the other hand, water-planting was the common planting method. The seed was frequently soaked in water and partly germinated, as in Asia, and then broadcast by hand on flooded fields (R.J. 6 [2, Part Two], p. 38). Occasionally, drill-planting was successfully applied. *DeBow's Review* (1856, p. 291) described:

> The seed is mostly broadcast and harrowed in, but this year several of the rice planters commenced the system of drilling, and on one plantation the drill plough, planting and covering four rows twelve inches apart... was successfully used.

Most rice-growers in the Gulf Coast Prairies depended on drill-planting for many years. The old-fashioned broadcast seeder was occasionally used on the fields where the ground was too wet to permit drill-planting (R.J. 6 [2, Part Two], p. 38).

As early as 1931, Arkansas rice farmers became interested in water-planting, though dry-planting was the common method at the time (R.J. 34 [5], pp. 8-9). In the South, water-planting normally was done with a team of drivers and horses (Figure III-8); however, airplanes were increasingly used for water-planting from the 1940s. By the mid-1940s, water-planting was accepted to a significant degree by the Gulf Coast farmers. By 1950, about 10 percent of Texas rice acreage relied on water-planting (R.J. 54 [2], p. 11). According to a survey conducted in the early 1960s in southwestern Louisiana, 95 percent of the rice acreage on clay soils and 66 percent of the rice acreage on the silty clay soils was being water-planted. The water-planting practice was gaining popularity especially among the rice farmers in the light-textured soil areas (R.J. February 1967, p. 23). The cultural practice of water-planting proved to be especially successful for weed control, particularly in controlling Barnyard grass [*Echinochloa crusgalli* (L.) Beauvois], one of the most serious weed pests in southern rice fields (see Chapter VI).

However, the water-planting method does not always produce higher yields compared with dry-planting techniques. A farmer should consider the weather conditions at the seeding time and the characteristics of his fields to decide

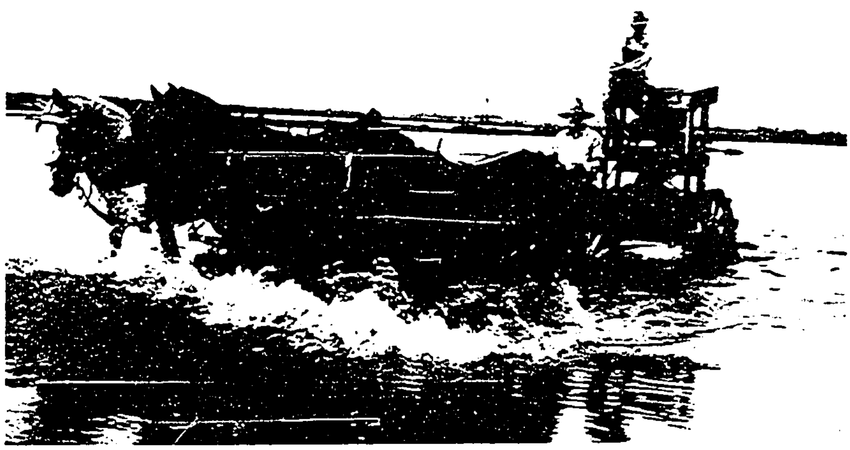

Figure III-8. Water-planting with a Team and Tail-gate Seeder before the Employment of Airplane Application (R.J. July 1944, p. 6).

which method to be applied. For the entire rice-producing regions in the South, half the rice-growers depend on the water-planting and the other half stay on the dry-planting. Robert Habetz, research associate at the Crowley Rice Experiment Station, says that it depends on the personal preference which method a farmer choose.

G) Water-Leveling and Laser-Leveling

In southern rice-fields, the irrigation water is kept on the land by means of levees.[2] The levees, located on contour lines, divide rice fields into smaller subfields, i.e., rice-cuts. The contour levees should be spaced so that the water in rice-cuts can be held at a average depth of 4 to 6 inches (Roberts and others 1950, p. 112).

In the late 1950s, it was found that rice fields could be leveled successfully when flooded with water[3] (Figure III-9). The water of the flooded field was used as a soil-moving agent. A larger amount of soil could be moved under water-leveling than under dry conditions. In 1960, M. D. Faulkner, an agricultural engineer at the Crowley Rice

2 Rice is often grown on steep slopes by means of paddy rice terraces, in some parts of mountainous Asian countries such as Korea, Japan, and the Philippines. Here do not exist the annually-built contour levees found in the U.S. South.

3 The Chinese have done water-leveling for 1,000 years or more.

Figure III-9. Water-leveling Operation on the Rice Field of the Rice Experiment Station at Crowley, Louisiana (R.J. June 1964, p. 30).

Experiment Station, tested water-leveling with great success. The water leveling method was introduced first on the rice fields that had hardpan, natural or artificial, at 8 to 12 inches below the soil surface. In the late 1960s, it could be applied even on the alluvial soils several feet in depth (Reech 1967, pp. 8-9).

Water-leveling permits growers to level a larger rice-cut than dry-planting, often resulting in a enlarged rice-cut with straightened contour levees. The water-leveled rice fields with parallel and straight levees make it easier to operate farm machinery in the fields, and also save rice acreage for planting. Once rice fields are water-leveled, they can be covered with a less amount of water and at a more even depth. Because of the uniform depth of water, water-leveled fields provide the uniformity of rice stands for better yields. More level rice fields not only save water for irrigation, but also make the fields dry uniformly (Stewart, Jr. 1964, pp. 29-30; Shults 1964, pp. 10-11; Kennerly 1966, pp. 29-30; and Sanders 1970, pp. 19-20).

Laser levels were introduced as an experimental basis in 1969 and proved to be fully effective in levee-making system in 1970 (R.F. February 1979, p. 14). Two laser instruments, made by laser rice-levee locator Control Instruments, Inc. at Huntsville, Alabama,[4] were first

4 The concept of a laser levee-making system was developed independently by T. A. Parker, a rice grower near Drew in Mississippi and by S. P. Matthews, a rice farmer at

applied to the levee-making system in rice fields in 1971. Twenty-five instruments were used in 1973. Parker used the laser system on a total of 3,400 acres of rice fields between 1971, 1972, and 1973 (R.F. January 1974, pp. 8-9)[5].

The laser levee-making system has three basic units: a plane generator (laser-beam projector), a detector (laser-beam receiver), and a read-out unit. The rapidly rotating laser beam from the plane generator creates a plane of light over the entire field. This plane provides a reference level for the levee marker. His tractor has a detector unit on the front of the tractor, and a read-out unit, which tells the driver where he stands in relation to the beam (R.F. January 1974, pp. 8-9; R.J. March 1979, p. 12).

The Rice Farming (June 1976, pp. 16-17) reported that the Raums, owners of 1,400 acres of rice farm near El Campo in the western portion of Texas rice belt, applied successfully laser level units to the leveling work in their rice fields in 1976. The laser units provided uniform

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Vinton in Louisiana. Matthews sold his right for method patent to Parker, who developed and designed the instrument for laser levee-making system with Carl Vought, an electronic engineer from Huntsville, Alabama. Parker and Vought's laser levee-making system was quite accurate with an error of one-quarter inch at 1,000 feet and one and five-eighths inches at one-half mile.

5 In the early 1976, more than four companies were supplying laser level equipments, including Control Instruments, Inc., Grand Rapids, Michigan; Laser-plane Corporation, Dayton, Ohio; Micrograde Laser System, Palo Alto, California; and Spectra-Physics, Mountain View, California (R.F. February 1976, p. 14).

leveling by sending a laser beam to a receiver mounted on the scraper [eleven-yard Caterpillar 613 Scraper], adjusting the scraper to the proper elevation, and scraping the ground to a predetermined depth. In the spring of 1978, Laser-plane Corporation at Dayton in Ohio introduced a laser plane system for use in land leveling application.

> The laser-plane system is designed to automatically control the blade of elevation of...scrapers used...in forming [leveling] and finishing farm fields. Finished grade accuracies of hundredths of a foot can be achieved on fields in excess of 72 acres in size... (R.F. April 1978, p. 14).

At the Crowley Rice Experiment Station the laser-leveling units were used in leveling work for the station's rice fields for the first time in the spring of 1988 (Figure III-10).

Laser-leveling is conducted without water, and so saves irrigation water. Laser-leveling is also efficient in converting irregular contour levees to straight rectangular levees. Southern rice farmers do not doubt the effectiveness of laser-leveling; the problem is, however, the cost. It is still costly to rely on the laser-leveling for most of the rice farmers.

H) Underground Pipeline Irrigation System

The rice fields adjoining water sources such as wells, streams, reservoirs, or lakes may be irrigated without long water-routes. But, in most cases, water should be drawn

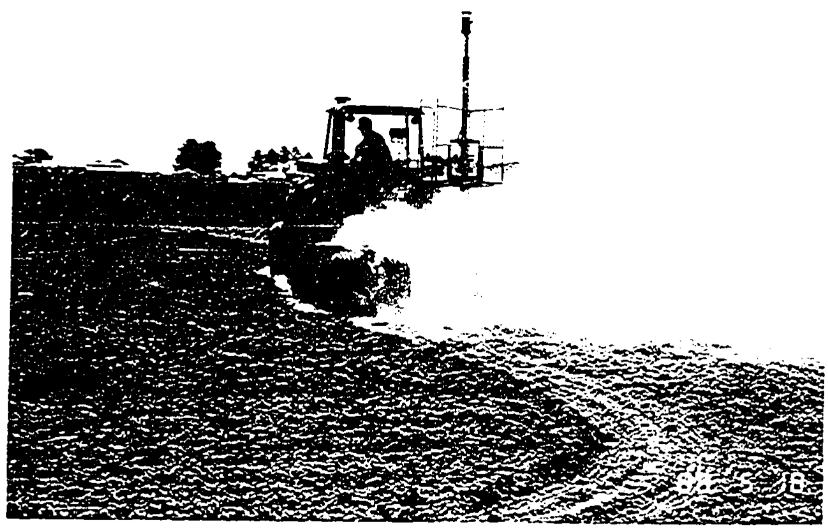

Figure III-10. Laser-leveling Work on the Rice Fields of the Rice Experiment Station at Crowley, Louisiana (Photo Taken by the Author on May 18, 1988).

from a distance through water-routes such as canals, ditches, flumes, or underground pipelines. During the last thirty years, the open water-routes gradually have been replaced with underground pipelines.

Pipelines, ditches, and pumps are used in various combinations in underground irrigation systems. An engine cooler, which is a kind of a radiator for the water-cooled engine, is the major accessory of the pipeline (Figure III-11). A flexible coupling and/or a check valve is used to prevent water from back-flowing. Next in line is a pressure gauge, followed by a pressure relief valve and a air release valve. All these accessories are mounted on a steel pipe above ground near the pump. The steel pipe is connected to the asbestos-cement or plastic pipe with a special adaptor. Mostly asbestos-cement pipes are used for pipelines for underground irrigation and less frequently plastic pipelines are also used. The pipeline beyond the adaptor is all underground except for water outlets and such places as canal crossings. A water outlet is placed within the highest point or cut in the field (R.F. February 1971, p. 10; Figure III-12). The average cost for the completely installed pipelines has been three or four dollars per foot.

James Ed Tarkington installed the first underground pipeline irrigation system on his farm near Almyra in Arkansas County, Arkansas, in the spring of 1958. In Arkansas, the rate of installation was 41,251 feet [7.81

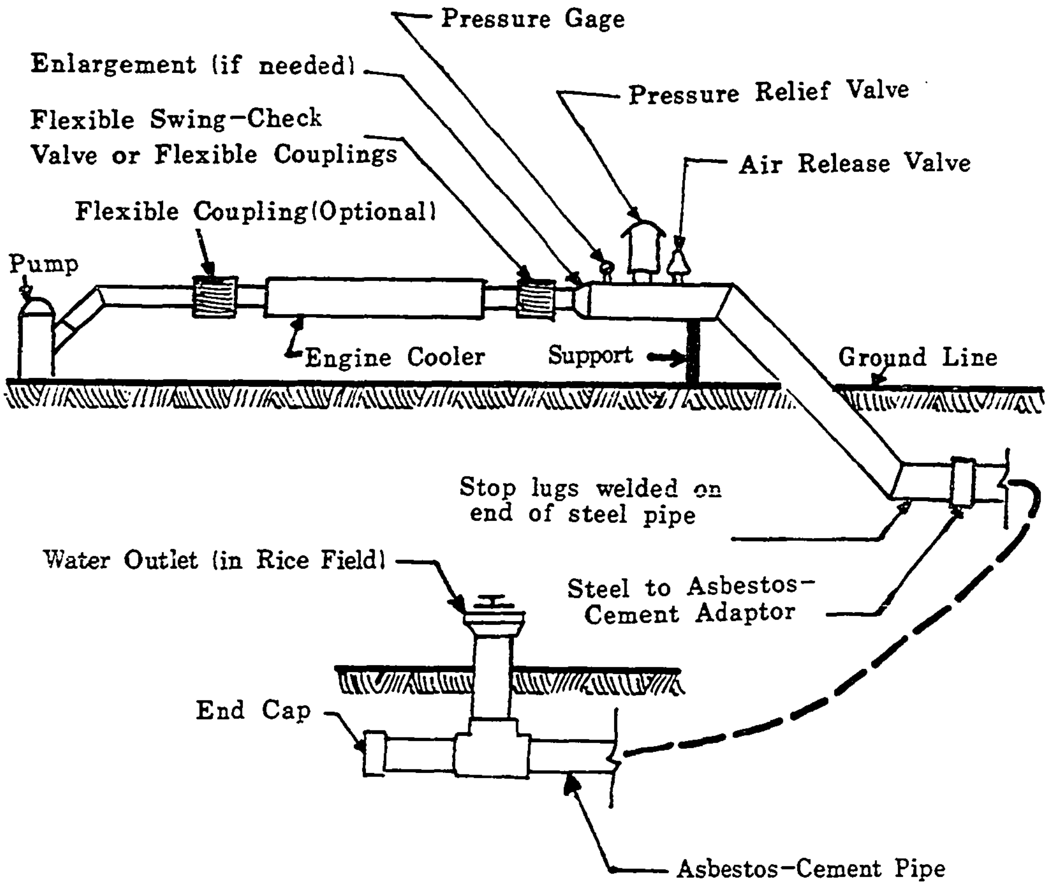

Figure III-11. Typical Irrigation for Asbestos-Cement Pipeline (R.J. July 1970, p. 8).

Figure III-12. Water Is Flooding through an Underground Irrigation System to Rice Fields at the Crowley Experiment Station (Photo Taken by the Author on May 18, 1988).

miles] in 1961-1962 and 117,000 feet [22.16 miles] in 1967-1968 (McElhannon 1969, pp. 17-18).

In Louisiana, 6,500 feet [1.21 miles] of pipeline was installed for the first time between July 1, 1964 and June 30, 1965. By December of 1968, the total length of the pipelines installed in the state was 207,000 feet [39.20 miles], of which about 58.4 percent [120,000 feet, i.e., 22.88 miles] were installed during the six months from July 1, 1968 through December 31,1968 (R.J. June 1969, pp. 19-20). By mid-1970, the total length of the pipeline installed in the state was over a quarter million feet (R.F. July 1970, p. 4).

In Texas, the underground system was first installed for the 1972 rice crop on the Rice-Pasture Experiment Station at Beaumont (R.J. May 1972, p. 19-20; R.F. July 1972, p. 6). By mid-1980, the total length of the pipeline installed in the state was 225,000 feet [42.61 miles] (R.J. Annual Issue 1980, pp. 18-19, 27).

An underground pipeline irrigation system has many advantages over conventional irrigation system (R.F. July 1970, p. 4; R.J. April 1973, p. 18). First, underground system can save or eliminate maintenance costs and rebuilding costs. It avoids the damage that may be done by burrowing rodents such as muskrat or nutria, or by a herd of crossing cows. The pipelines used in underground irrigation system are semi-permanent, having a life-expectancy of more than forty years. Second, underground system can easily overcome the large elevation difference between the water source and the rice fields. This second advantage is very important because, in many cases, water sources such as wells, reservoirs, and streams are located in low areas of the farm, somewhat below the areas needing water. Third, underground system can save land, permitting the farmer to fill in canals and farm over the area. Canals often occupy up to three percent of rice fields. This land can be reclaimed for rice-growing. Fourth, underground system reduces overall pumping cost by saving water from seepage, soaking, and evaporation. Fifth, it facilitates timely water management, permitting water to be delivered more promptly to rice crops in proper amounts than conventional irrigation system. In the conventional irrigation system, it may take even up to twenty-four hours for the water to soak up the ditches, the holes and the cracks along open water-routes. Finally, another advantage results indirectly from the fact that canals and many of the levees are destroyed. The canals and levees are a major breeding-ground for weeds, insects, disease, and snakes. The underground system protects efficiently water not only from weeds, insects, and disease but also from pesticide pollution.

SCS (Soil Conservation Service) engineers have offered assistance in design and cost estimates. County (or parish)

ASCS (Agricultural Stabilization and Conservation Service) offices have financially supported the underground pipeline system by sharing the cost in the installation to the extent that funds have been allocated (R.F. July 1970, p. 7).

I) Tests of Sprinkler Irrigation Systems

The sprinkler system was first tried for rice irrigation on a 10-acre plot in the Delta Branch Experiment Station at Clarkedale, Arkansas, in 1976 and again the next year. A circular, center-pivot sprinkler was used, and the results were remarkably successful (R.F. February 1978, p. 28). In 1978, Jim Burton, a Arkansas rice farmer at Tupelo, planted 140 acres of rice that depended entirely on the center-pivot sprinkler irrigation system, thereby proving the economic feasibility of sprinkler irrigation system (R.F. April 1979, pp. 8-11). In 1979, Larry Holub, a Texas rice grower at Louise, grew rice on 160 acres of his land under a lateral-moving sprinkler system, the first experiment in Texas (R.F. February 1980, pp 34-37). Using center-pivot irrigation system, Hiram Cross, a Arkansas farmer at Lepanto, grew rice in 1980 on 30 acres of uneven ground where irrigated rice could never have been grown using any other system (R.J. June 1981, pp. 12-13). In 1981, Walter Pugh, a Mississippi farmer near Belzoni, grew rice on 68 acres of his land under a center-pivot irrigation system (R.F. June 1982, pp. 20-22).

The major advantage of the sprinkler system is economy of irrigation water. It also saves through elimination of land-leveling and levee-making, for rice can be grown, if sprinkling is used, on fields with somewhat sloping ground. In sprinkler system, rice fields are more easily drained and dried because of the sloping ground, and the drier land makes rice drier during periods of rice harvest. Therefore, less fuel is needed for rice drying for the rice harvested from the rice fields under sprinkler system. Fertilizers and chemicals, if mixed with water, can be applied more efficiently with the sprinkler system than under the aerial application.

In spite of such advantages, universal acceptance of sprinkler system seems a long way off, for the grower must still contend with pesky weeds. Moreover, initial costs of installation are high and yields are relatively low.

CHAPTER IV

TOOLS AND MACHINERY: MECHANIZATION OF RICE FARMING

A) Elementary Tools and Machinery for Rice Culture

Mechanized rice farming in the South dates from the late nineteenth century. Prior to that, they depended largely on simple implements for planting, harvesting, and milling, scarcely improved from those of the Middle Ages. In fact, many of the implements used on the rice plantations of the South Atlantic Hearth were almost the same as those used in China at that time. Both in the South Atlantic Hearth and in China, sickles were used for stalk cutting; flail-sticks for rice threshing; mortars and pestles for rice milling; hand-fans for rice winnowing; and baskets for transportation (Heyward 1937, p. 10).

For years Carolina and Georgia rice seed was sown by hand and covered with a wooden toothed harrow (Maher 1905, pp. 19-20). Around 1812, Dr. Robert Nesbit, a native of Scotland, introduced a drill plow, which could open trenches and sow seed into them. It was used successfully for several years by Dr. Nesbit and some of his neighbors on the plantations near Winyah Bay, but after his death in 1821 the drill was abandoned. This was not because it was not useful, but with a surplus of labor hand-sowing was preferred. Another attempt was made in the mid-1840s by Robert Allston (1846, pp. 339-340) who reported that he had ordered from Scotland an improved drill plow and a laborer who was familiar with its use. He described the function and the shape of the machine:

> The drill plow was borne by a carriage on two wheels, very much resembling in size and height an ordinary dray, and was drawn by one horse between shafts. It consisted, generally, of a long box parallel with the axle and above it, into which the given quantity of seed grain was placed and locked up. From this box the grain was distributed by means of regulators into through tin tubes, descending nearly to the earth, at the required distance from each other for planting....

In southern Louisiana along the Lower Mississippi River, rice seed normally was broadcast on the flooded fields. Therefore, drills rarely were used in the rice fields. The transplanted Midwesterners, who settled in southwestern Louisiana in the 1880s, brought drills from far north and used them for rice planting.

The sickle was the principal implement for rice harvesting before rice harvesters were introduced. One person, advancing in a dried rice field with a sickle, could cut three or four rows of rice at a time, resulting in a harvest of from one half to three quarter acres of rice in a day (Lee 1960, p. 137).

Threshing was equally primitive; rice was threshed with flails or tramped out with animals. The animal treading method, which was practiced widely in the South before the threshing machine was used, was described by Wilkinson (1848, p. 56).

> ...eight or ten tackeys, or small horses, are tied to one to another to a post; the rice is placed on the ground about three feet deep, the heads up, the animals are made to trot around, occasionally shaking up the rice. In this way about twenty barrels [32.4 cwt] per day are usually trodden out.

The mortar and pestle was used for rice milling throughout the South (Figure IV-1). The husk was removed by pounding the grains in a wooden mortar with a wooden pestle. The mortar was made from a section of log hollowed out, and the pestle was made from a stick of oak or cypress about four feet long (Maher 1905, pp. 19-20). The milling with a mortar and pestle was conducted on the floor of large barn prepared for the purpose. The simple mortar and pestle evolved into a more elaborate mill where the pestle was mounted on a horizontal beam and worked by animal, water, or steam power. Dubbed a "pecker" because of the resemblance of the operating machine to the action of a woodpecker,[1] the capacity of such a pecker mill was increased simply by mounting several in a row to be driven by a common shaft. In 1787, Jonathan Lucas, a South Carolinian, erected the first water-mill on the Santee river in South Carolina (Allston 1846, pp. 342-343; Evans 1921, p. 19). Rice milling came to be big business in the state, and by the

1 Water-powered pecker machines were also used in China, in the Sung Dynasty. The author has observed that a variety of pecker machines were being used in rural areas of South Korea in the 1960s and in the 1970s.

Figure IV-1. A Mortar and Pestle Used for Shelling Rice by the Louisiana Cajuns (Crowley Signal January 30, 1904).

1840s there were a lot of toll mills in South Carolina, nearly sufficient for preparing all the rough rice which was not pounded at the plantations (Allston 1846, p. 344).

B) Threshers

In 1811, Dr. Robert Nesbit imported and used a Scotch threshing machine in the South Atlantic Hearth. The threshing machine, powered by the wind, could "thresh and winnow five hundred bushels [225 cwt] in a day" if "the wind was fresh and the weather fair" (Allston 1946, p. 340). Since then, there were several attempts to adapt a wheat thresher into a rice threshing machine with little success. Finally, a successful threshing machine was invented in 1830, the beaters of which were shod with sheet iron and serrated with iron wire. This machine could thresh 200 or 300 bushels [90 cwt or 135 cwt] a day when worked by animal powers, but could thresh 450 to 700 bushels [203 cwt or 315 cwt] when propelled by steam. The threshing machine was in general use in the 1840s in the South Atlantic Hearth (Allston 1846, p. 340).

Mechanization developed in the South Atlantic Hearth, while rice growers in southern Louisiana along the Lower Mississippi River clung tenaciously to the old threshing methods, such as flail or animal treading threshing. The threshing machine developed in the South Atlantic Hearth was brought to the Lower Mississippi River Delta after the Civil War, probably by migrating South Carolina rice planters (Lee 1960, p. 137). In the prairies of southwestern Louisiana, the Cajun growers had developed a threshing contrivance that consisted of several large rollers, but its success was limited owing to the great loss incurred on account of broken grain. Although some progress was made toward the development of a rice thresher, the machine that proved successful was the grain thresher developed in the Midwest for threshing wheat and other small grains. Its introduction dates from the 1880s, followed quickly by steam engines needed to power the threshers. In the early days of the steam thresher, as many as twenty-five men had to work together to operate one outfit. By 1903, fourteen men were considered sufficient to operate one thresher and its associated activities (R.J. 6 [2, Part Two], p. 53).

C) Rice Harvesters: Binders

Much has been written about the development of the reaper. Every schoolchild knows of Cyrus McCormick and the impact of his machine on grain farming. Much less known are the rapid improvements made after its initial introduction. Perhaps the most important was the development of a twine knotting device that enabled a reaping machine to cut grain and bind the stalks into bundles, hence the name "binder."[2] Although developed primarily for wheat, the binder worked equally well on rice, and Louisiana rice farmers were quick to adopt it for rice. According to one writer, a single machine was in operation in 1884, five were in use the next year, fifty in 1886, two hundred in 1887, four hundred in 1888, and one thousand in 1890 (Ginn 1940, p. 22). More labor efficient than a reaper, the binder cut the rice stalks and bound them into bundles, which were then shocked by hand to dry for ten days or two weeks in the field before threshing.

A variety of rice harvesters were introduced and developed in southwestern Louisiana. Two men and four mules with a harvester could harvest fifteen acres of rice in a day, formerly the work of forty men with sickles (Ginn 1940, p. 22 and p. 31). Ginn wrote:

> In 1890, 'the Osborn rice harvester' was widely advertised. It was a steel-frame machine, and because of improvements suggested by the experience of past years it gave excellent satisfaction to the numerous users. One of these machines would do the work of thirty or forty men. The saving in labor in a short time would entirely repay the cost of the machine. In 1892, 'the Randolph rice header' was built by a prominent planter. This machine cut three times as much rice as any of the others and was lighter and therefore easier to manipulate. In September 1894, an

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2 The harvester and binder --- the placing of men on the machine to do binding --- was first developed in 1850 by Augustus Adams and J. T. Gifford Elgin, Illinois. A number of different binders appeared before a twine binder was first developed in 1858. In 1881, the McCormicks' developed the Appleby-type twine binder, and by 1884 had sold 15,000 twine binders.

> improved harvester was offered for sale at Jennings. It cut a swath ten feet wide, and therefore harvested twice as much rice as earlier machines, and it required no additional hands or teams.

Before combines were introduced in southern rice fields around World War Two, most southern rice was cut with the harvesters. Five men, following one harvester, usually worked for the shocking. After rice was cured in shocks, it was hauled to a point where to be threshed with threshers.

D) Tractors

Tractors were slow in coming to the South, but in the rice fields they found ready acceptance, the process of mules being replaced by tractors in rice fields during World War One (Daniel 1985, p. 56). By the end of 1918, many rice growers who owned tractors had already disposed of their draft animals to reduce feed bills. Instead of draft animals, tractors pulled the harvesting machines on the rice-fields. Tractors were also used for various purposes on rice farms (R.J. 21 [11], p. 36):

> When plowing is to be done, in the spring or early fall, the tractor will do the job better than horses because it can plow deeper, work faster and longer, do more uniform work and with less labor for the operator, than can horses. In building or repairing levees, or in digging canals or laterals, the tractor furnishes adequate power for the work and is more easily handled than horses. When the rice has been cut and stacked ready for threshing, the tractor is an ideal form of power to use in operating the thresher.... When the rice has been sacked and placed on trailers or wagons, the tractor will haul at one trip six or seven of the loaded wagons and the grain will be taken to the mill

or warehouse without delay.

E) Electrification

Electric power lines were first introduced on the southern rice farms in the Gulf Coast Prairies during the latter half of the 1920s. After the Gulf States Utilities Company was organized in 1925, the company together with rural cooperatives began to furnish electricity to rural farms and ranches (R.J. 53 [2], p. 36). The electricity began to be used as a power source for water pumps in southern rice farms. By April 1926, over one hundred and fifty wells in the Arkansas rice belt were operated with electricity (R.J. 29 [5], pp. 22). Electric pumps together with internal combustion pumps gradually replaced the steam-driven pumps. From the time of introduction until around 1937, electricity service diffused slowly. By 1937, only 2.3 percent of the Louisiana farms received electric service from power lines (R.J. 40 [7], p. 10). Electrification increased rapidly after World War Two. By the close of 1949, about three quarters of all the farms and ranches along the Gulf Coast Prairies received the benefit of electric service (R.J. 53 [2], p. 36).

F) Rice Drying Machine

Rough rice coming from the thresher is usually too wet for storage or milling. Artificial drying increases grain hardness, minimizes stack burn, and decreases rot and mildew. Natural air drying can accomplish the desired results but it takes too long and requires large storage capacity. Rice brokers already knew the advantages of practical rice driers by the turn of this century. The _Rice Journal_ (6 [8], p. 33) reported in 1903:

> A large part of the stack-burn occurs after rice reaches the mill. If rice could be well dried when it first reached the mill, this deterioration would be prevented. Rice that has not reached the proper degree of dryness does not yield as much head rice as well-dried grain would. Wet rice gums the hullers and is crushed by the stones. These are the reasons why a practical and economical drier is very much desired.

As early as 1903, A. Hanak of New Orleans invented a rice drying machine and tested it in a rice mill at Crowley. The drier was capable of drying 15 bags [27 cwt] of rough rice per hour (_R.J._ 6 [8], p. 33). Experiments with many different types of driers were carried on for years, but a practical unit was not developed until 1919, when Ellis drier was proven to be successful by the tests conducted in the Pritchard Rice Mill at Houston (_R.J._ 22 [4], p. 40).

In 1930, a drier was installed at Nome, Texas, by the Texas Public Service Company of Beaumont for the benefit of rice growers in that area. Although capacity was limited, it was operated successfully (_R.J._ 47 [4], p. 10). Despite such success, drying on a large scale was a costly undertaking, and individual growers could not afford the expense (R.J. 33 [9], pp. 9-10). It was in the 1930s that rice-drying systems were improved dramatically (R.J. 38 [8], p. 11).

The use of driers in southern rice belts was greatly stimulated by two factors: the use of combines and bulk rice storage. In fact, the installment of rice driers spread in the 1940s hand in hand with the expansion of combine harvested rice and the enlargement of bulk rice storage facilities. The moisture content of rice harvested with combines is high, around 20 percent. To store the rice safely, this percentage must be reduced to about 14 percent, hence the necessity of artificial driers. In 1945, twenty-nine rice driers were in operation within Louisiana. The next year, the number increased to thirty-nine. Of the thirty-nine driers, six were the relatively small on-farm type driers and the other thirty-three were the commercial type driers (Efferson 1947[a], p. 9).

Since the early 1950s, reports in the Rice Journal and the Rice Farming have often referred to the development of drier technology with topics such as drying rice with natural air, drying rice with heated air through aeration, drying rice with infra-red energy, and drying rice with solar radiation. Work on a solar drier began at the Beaumont Rice-Pasture Experiment Station in 1975.

G) Combines

The combine is precisely what the name implies, a combination binder-thresher. It cuts the grain stalks and separates the grain from the straw and chaff in a single operation while moving through the field. Obviously, its use postdates the development of both the binder and the thresher.

It was attempted, as early as 1828, to combine the operations of harvesting and threshing of grain but without remarkable success. The first widespread success in the use of combines for grain harvest began around 1880 in the states along the Pacific Coast. Immediately after World War One, the combine was introduced in the grain farms on the Great Plains (Hurst and Humphries 1936, p. 1).

In the harvesting seasons of 1920 and 1921, a rice stripper was experimentally used by G. I. Dill and G. A. Dill of the Dill Tractor Manufacturing Company at Little Rock, Arkansas. Using an ancient idea, the stripper was so constructed that it harvested rice by combing it off the straw and leaving the straw standing in the field. Although the Dills envisioned replacing both the binder and thresher with the stripper, the Dill stripper never materialized (R.J. 25 [1], p. 26). In 1929, a few combines were imported into Texas from the wheat belt farther north. The combines enjoyed limited success but were hampered because they were not specifically designed for rice harvesting and because existing drying facilities could not accommodate a large amount of rough rice (Magee and McCune 1944, p. 10). In time, though, the machines were modified to perform better in rice.

Extensive use of combines began around 1940, and within a decade almost all the southern rice was harvested with combines. Generally, the large-scale rice farms employed the combine-drier system first, and then the smaller farms followed. Texas rice farmers adopted the combines earlier than Louisiana rice producers. In Louisiana, only 22.5 percent of the total rice acreage was harvested with combines in 1945; the percentage increased to 44.6 percent in 1946 (Efferson 1947[a], pp. 8-9). Parishes adopted combines at different rates (Figure IV-2; Table IV-1; Figure II-9).

Table IV-1. Proportion of Rice Acreage Harvested by Combines in 1945 and in 1946 in Louisiana

Parish	Acreage harvested by combines		Percentage harvested by combines	
	1945	1946	1945	1946
Cameron	7,000	14,000	35.0	70.0
Calcasieu	37,500	40,800	50.0	60.0
Jeff. Davis	30,000	69,000	25.0	60.0
Vermillon	30,000	67,500	21.7	50.0
Acadia	18,450	40,000	15.0	32.0
Allen	3,800	8,000	13.6	32.0
St. Landry	3,200	7,200	12.8	30.0
Evangeline	1,000	5,000	1.9	9.6

Source: Efferson 1945[a], p. 10.

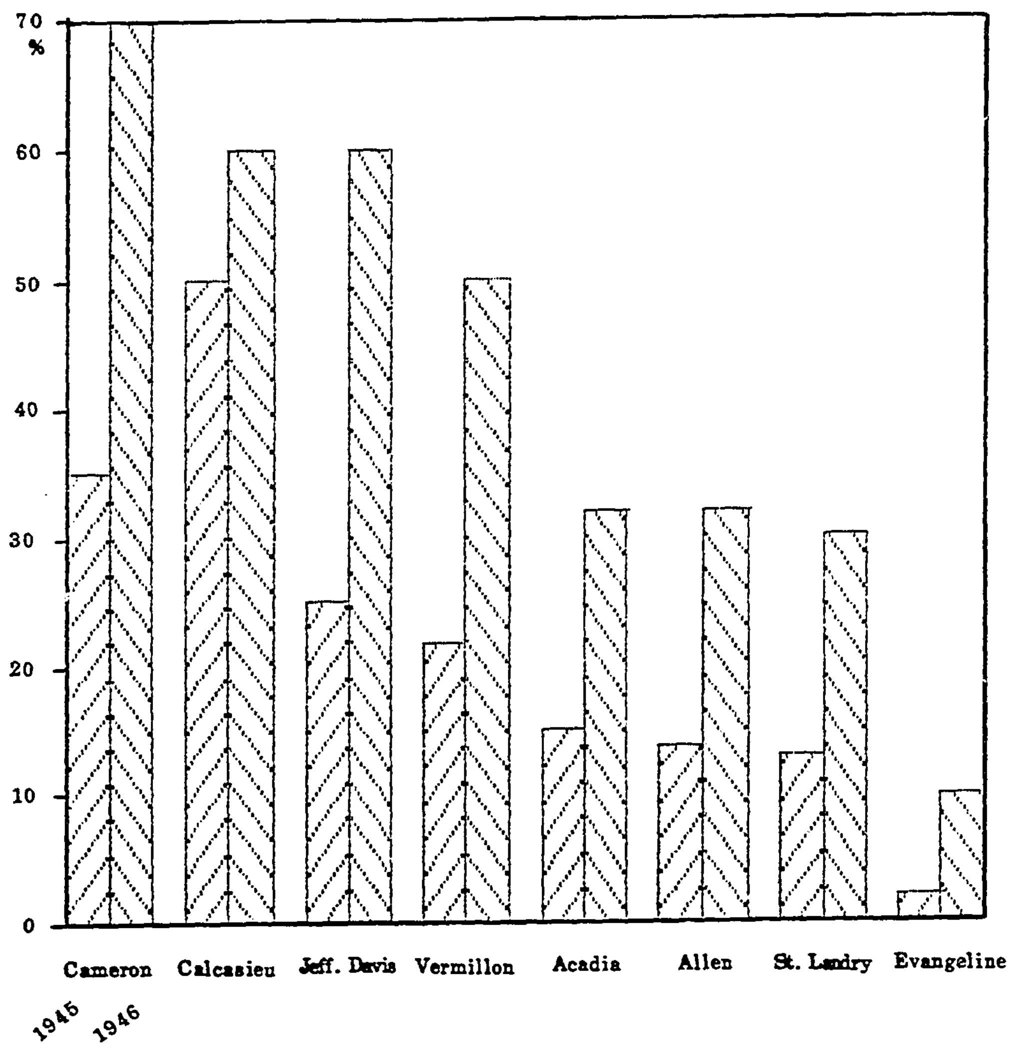

Figure IV-2. Proportion of Rice Acreage Harvested by Combines in 1945 and in 1946 in Louisiana (Efferson 1945(a), p. 10).

In the 1940s, two different types of combines were in use: self-propelled combines and smaller pull-type machines. The size of the former's cut was commonly fourteen-foot, whereas the cut of the pull-type machine was of six-foot or seven-foot size. Combines usually operated together by two in rice fields. In a 7.6 hour day, two of the large self-propelled combines cut an average of 27 acres; in the same hours, two of the pull-type combines cut an average of 18.4 acres. It took two men with tractors and bulk wagons or carts to haul the grain from the combines to the farmstead or drier. The pull-type combine was towed by a tractor, and, providing the rice was not bagged, only one operator was needed (Magee and McCune 1944, pp. 10-11). Generally, four men under the combine-drier method could harvest the same amount of rice as a crew of about twenty-four to forty men operating binders and threshers (R.J. 46 [10], p. 7; R.J. 46 [9], p. 14; and R.J. 47 [1], pp. 5-6).

The combine system also helped rice farmers to protect themselves from weather and bird hazard. When rice was harvested in the binder-thresher method, the piled shocks were easily rotted if soaked through in case of heavy rain storms. Or rice cured in the shocks might be cracked or damaged by sun or high temperature. When rice farmers employed the combine system, they did not have to wait until their rice land became completely dry. The self-propelled combine mounted on caterpillar tracks could work well on muddy fields. The combine equipped with a pick-up reel could save most of the lodged rice (R.J. 47 [1], p. 6). Blackbird damage was greatly reduced with the combine system, because as soon as the rice crop matured it was harvested and quickly stored.

Finally, the most important factor was the reduction in harvest costs. When the combine-drier system was used instead of the conventional binder-thresher method, overall cost for rice harvest, depending on the type and size of combine used, could be reduced up to 74 percent (Salter 1944, p. 6; Magee 1944, p. 8). In the early 1940s, many combines not designed for rice harvest were still used on the rice farms. As these combines were gradually replaced with the combines well adapted to the rice harvest, the cost for combining decreased.

E) Bulk Rice Storage

Rice storage offered the producer the advantage of time. He could hold his crop as long until market situation became satisfactory. Lacking storage facilities, he was at the whim of the prevailing market. With the bulk rice storage, a farmer could also save the high cost of labor and sacks (R.J. 7 [10], p. 18; R.J. 21 [7], pp. 28-29). The shortage of bulk rice storage facilities became a major problem after the combine system was adopted on the southern rice farms. In 1951, the total storage capacity of the 75 storage units in Texas was close to 6 million barrels [9.72 million cwt]. None of the 75 units were located on farms; all were commercial. Eighteen were bulk storage units; the other fifty-seven handled sacks only. The capacity of the eighteen bulk storage units was but 686,000 barrels [1,111,320 cwt], only 8 percent of Texas rice crop (Barr and Coonrod 1951, p. 13). The remainder had to be stored in sacks.

Many rice drying and storage facilities (Figure IV-3) were installed in the 1950s. By 1957, about 300 firms were in operation for drying and storage of rough rice in the South. In Arkansas alone, there were 104 rice drier or storage firms (R.J. Annual 1967, p. 79). By 1967, more than 400 firms were concerned with rice drying or storage in the South with Arkansas accounting for 136 units. Recently, many rice-growers have opted for on-farm storage. With such facilities, they can wait in order to take greater advantage of the seasonal rise in price.

I) The Airplane as a Farm Machine

In the United States, airplane application of insecticides began in 1921 near Dayton, Ohio, where lead arsenate was applied on Catalpa trees (R.J. 50 [3], p. 20). The first airplane application for rice seeding was in

Figure IV-3. Rice Drier and Storage in McGehee, Arkansas (Photo Taken by the Author on May 31, 1988).

California in 1929. Apparently, it was quite successful![3] (Bates 1930, p. 12; R.J. 33 [7], p. 49). In the following year, about 50,000 acres of rice were seeded in the Sacramento Valley by airplane.

In the South, the first airplane application to rice seeding was in the Arkansas Grand Prairie in 1941 (R.J. 44 [4], p. 3):

> Paul Wallworth, who lives east of the city [Stuttgart], is trying out a new plan for his planting rice. Heavy rains of the past several days have prohibited sowing the seed with machinery and he secured the service of J. O. Dockery to fly over marked areas and drop the seed from a plane...but using them for rice planting is something entirely new in this section....

By 1946, rice was seeded by airplane on several thousand acres of rice fields along the Gulf Coast Prairies. Since then, total acreage planted by airplane has increased rapidly. At the present time, the use of the planes for the application of all bulk materials is commonplace throughout the southern rice-producing areas.

Aerial seeding is done in one of two ways, wet or dry. In the former, rice seed is broadcast directly onto dry fields and then flooded. In the latter method, sprouted seed is dropped in fields that have been flooded previously.

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3 The Cooker-Huffman Land and Water Company of Merced, California, found early in May 1929 that flocks of migratory mudhens had almost completely destroyed the seeding on one section of their rice land, so they finally decided to try airplane broadcast-seeding over the affected section. They enlisted the services of their local commercial airplane proprietors, Mr. Frank Gallison and Mr. L. F. Tedrow (Bates 1930, p. 12).

The latter method is preferred increasingly by the southern rice farmers. Not only are airplanes being used for seeding rice but also for spraying fertilizers and herbicides, in fact any kind of chemicals. In addition, invasions of insects and disease are more quickly identified from the air.

In recent years, fixed-wing aircrafts have given way to helicopters. Spray applications from helicopters often give better coverage than from the fixed-wing planes because the downwash from the helicopter motors forces the spray onto the crop. In closely bounded rice fields, a helicopter can provide better herbicide coverage near the edge of rice field to reduce spray drift to nearby susceptible crops (R.J. April 1971, p. 14; Figure IV-4).

Figure IV-4. Aerial Application of Herbicide in Rice Fields (R.J. April 1968, p. 25).

CHAPTER V

IMPROVEMENT IN RICE VARIETIES

There are thousands of rice varieties in the world.[1] In the South, hundreds of varieties have been grown for commercial use during this century and more than sixteen varieties were grown in a single year of 1984. In 1987, fourteen varieties were grown commercially in Arkansas[2] alone (Figure V-1; Appendix VI).

The varieties differ in shape and color of grain, in growing season for maturity, in the requirement of water, in grain and milling yield potential, in the resistance to disease, in the straw strength, in the cooking and processing characteristics, and in many other characteristics. Rice varieties are often classified into long-grain, medium-grain, and short-grain varieties according to the shape and size of the grain, and early-maturing, and late-maturing varieties according to the growing seasons for maturity.

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1 In India, about eight thousand varietal names have been recorded, and in Philippines, some three and half a thousand varietal names were known (Copeland 1924, p. 131; Jones 1936, p. 425). In Ceylon alone were there 161 rice varieties at the first decade of this century (Knapp 1910, p. 5).

2 Recently, about half of southern rice is produced in this state.

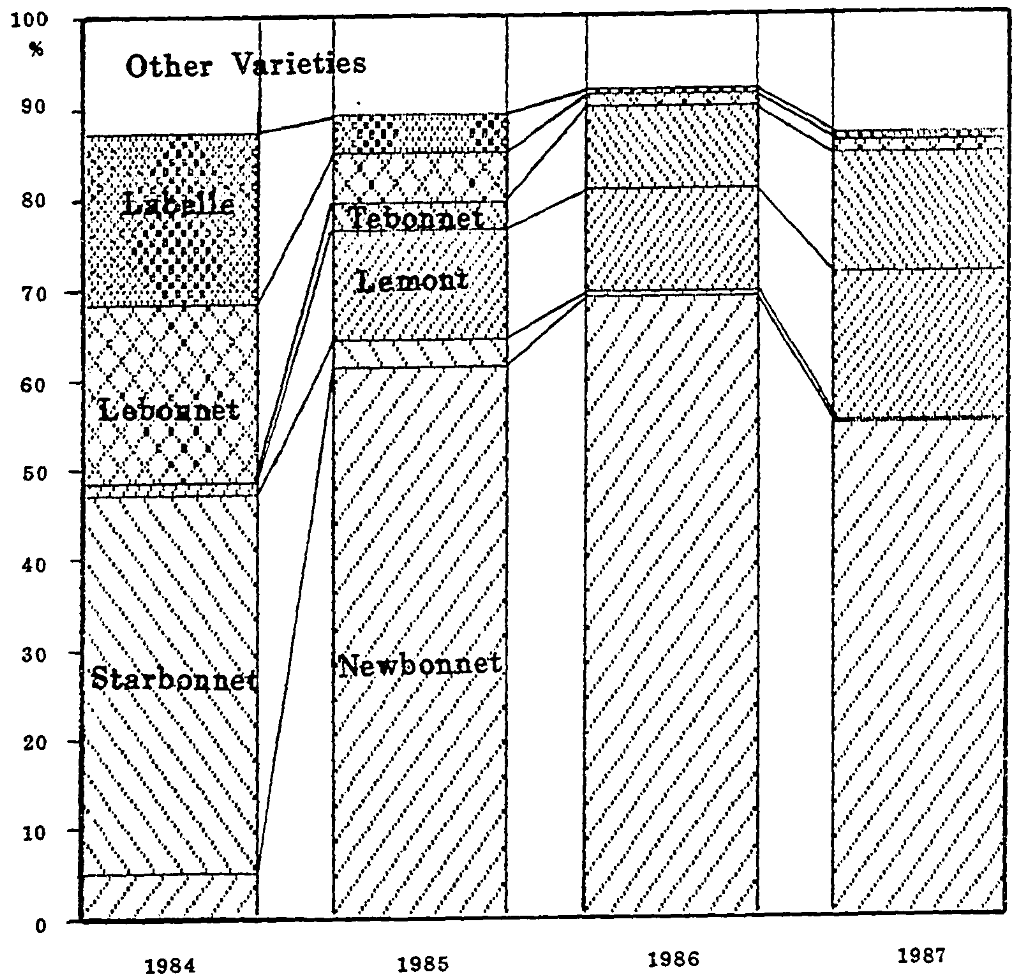

Figure V-1. Percentages of Rice Varieties in Arkansas, 1984 -1987 (Cooperative Extension Service of University of Arkansas 1988, Leaflet 518).

Rice is also grouped into lowland [wetland] varieties and upland [dryland] varieties. The former varieties are grown on land that may be submerged with water varying in depth for some time during the growing season, whereas the latter varieties are grown without such inundation. Lowland rice is much more widely cultivated throughout the world than upland varieties (Jones 1936, p. 425). Although upland rice was grown on a small scale in many parts of the South from the early days of rice culture in America, most southern rice has been lowland rice. Inherently less productive, upland rice was grown without irrigation on uplands or lowlands, in most cases for home use, either for food or for livestock and poultry feed (Jones and others 1952, pp. 11-12, 32-33).

In the South, the principal varieties have changed through time. In the earlier days of rice culture, when the science of plant breeding was in its infancy, a small number of varieties accounted for most of rice production and the adoption of new varieties happened rarely. Recently, especially since the mid-1940s, varietal change has become more dynamic due to dissemination of information from active research on varietal improvement and breeding at experiment stations of the rice-producing states. Introduction of high-yielding varieties, price changes in different rice varieties, and the prevalence of disease have been mostly responsible for proliferation of rice varieties grown in the

South. The stimulus for varietal change came, not only from as desire to improve productivity and quality, but from the need to adapt the plant to mechanized handling. New varieties often were judged on their suitability for combine harvesting and artificial drying.

Carolina Gold was the most popular variety in the South until about 1880s. Honduras rice and Japan rice, imported from their respective countries, replaced the Carolina Gold variety during the late nineteenth century and became the dominant varieties for many decades in the South. Beginning in the 1910s, new varieties were selected and improved from the imported varieties and distributed in the South. Some were crosses developed from two or more varieties and distributed for commercial use in the South.

A) Carolina Gold and Carolina White

Carolina Gold and Carolina White were well-known varieties in the South Atlantic Hearth. But Carolina Gold had a larger and harder grain and enjoyed the greater popularity of the two. The outer husk of Carolina Gold grain was golden-yellow, hence its name (Quereau 1914, pp. 3-4). Carolina White tended to shatter more easily when harvested than Carolina Gold.

There are different accounts about when and how the two varieties were originally imported. Without sufficient evidence, Carolina Gold is believed to have been derived from the Madagascar's rice seed and the Carolina White, from the rice seed sent from East India (Gray 1958, vol. 1, pp. 277-279). In his famous essay, Seed from Madagascar, Duncan C. Heyward stated that the Carolina Gold had been originated from a bushel of rice seed which, in 1685, Captain John Thurber gave Dr. Henry Woodward. Heyward contended that the Carolina White probably had been brought from China during the latter half of the eighteenth century (Heyward 1937, pp. 1-10).

According to R. E. Allston's description of rice varieties in South Carolina in 1846 (Allston 1846, p. 326), four varieties of rice were most common there: Carolina Gold, the most universally cultivated rice variety; Carolina White, with white or cream-colored husk; Guinea Rice, so called from the resemblance to one of the varieties of Guinea corn, in the shape of the head and clustering of the grains; and White Bearded Rice, brought from the East Indies in 1842, very much the same as Carolina White but with a larger grain.

Probably, rice seed was brought into the South Atlantic Hearth from various parts of the world. Among the numerous varieties, Carolina Gold and Carolina White proved best suited to the physical environment and the cultural practices of the South Atlantic Hearth. Carolina Gold rice seed was brought into Louisiana in abundant amounts in the mid-1850s. Soon the variety became the leader in Louisiana and maintained this position until the 1880s, when Honduras rice became popular in the state.

B) Creole (or Louisiana) Rice and Honduras Rice

The milled grains of Louisiana Rice were not as white as those of Carolina Gold or Carolina White. The grains of Louisiana Rice were also more apt to break during milling than Carolina varieties. Despite these characteristics, Louisiana Rice was considered a sweet variety and was popular among the consumers in Louisiana (Wilkinson 1848, p. 53). It was the principal variety grown in Louisiana during the colonial and antebellum periods.

Rice seed was imported from Honduras[3] in 1881. The imported rice was found to grow well in Louisiana but, after repeated tests, was found unsuited in the South Atlantic Hearth (R.J. 23 [11], p. 36). When the transplanted Mid-westerners began to develop the prairies of southwestern Louisiana in the 1880s, Carolina Gold and Honduras were the two most popular varieties. Of the two varieties, Honduras ranked higher for grain size, richness of kernel, and yield and came to replace other varieties. Honduras was one of the principal varieties on the prairies of Louisiana, Texas,

3 Probably rice seed was introduced not from Spanish Honduras but from British Honduras [Belize].

and Arkansas until the early-maturing [about 125 days] long-grain varieties such as Edith and Lady Wright replaced it in the 1920s (R.J. 45 [12], p. 16).

C) Japan Rice: American Pearl

The term "Japan Rice" referred not to a single variety but a number of varieties that were imported from Japan. Generally, Japan rice matured late and had a short thick kernel and very short and stiff straw. As it contained a higher percentage of gluten than other varieties, it was sticky when cooked. It proved its profitability in the experiments conducted in Louisiana in 1892 and 1893. The percentage of bran and polish, by-products of rice milling, was lower than that of Honduras, and Japan Rice required much less water to grow than Honduras. Japan Rice quickly gained in popularity among the Louisiana rice farmers (Ginn 1940, p. 30; Quereau 1914, pp 3-4).

Dr. Seaman Knapp of the U.S. Department of Agriculture visited Japan in 1898 in order to study the rice culture of Japan. Upon returning in 1899, he brought ten tons of rice seed of the Kiushu variety, which proved to be well suited to the soil of Louisiana and far more profitable than the Honduras rice. In 1902, an additional 1,000 tons of the rice seed of the Shinriki variety was imported by Knapp (Jones 1936, p. 442). Soon it became the leading rice variety in the South and kept this position until the late 1910s. S. Sabaira, a Japanese rice grower in Webster, Texas, first introduced the Wataribune variety from Japan in 1908. The seed from this crop was sold by J. A. Lambert, Houston under the name "Watari." The Wataribune variety was never extensively cultivated in the South, though Wataribune and selections from it were the principal varieties in California from 1912 to 1918 (Chambliss and Jenkins 1923, p. 12). The Omachi variety was introduced from Japan in 1910 by a Crowley rice grower but was never extensively cultivated in the United States (Jones 1936, p. 442).

Because of anti-Japanese sentiment during World War Two, the name for the class of Japan Rice was changed to American Pearl. The subclass names Japan and California-Japan were also changed to Southern Pearl and California Pearl.

D) Sol Wright's Varieties

Salmon Lusk Wright (Sol Wright) was born on a farm in western Indiana on April 26, 1852. He married at the age of twenty-one and moved to Oregon, where he engaged in wheat growing for ten years. Later he moved to Louisiana in pursuit of favorable climate for the health of himself and his family. In 1890, he bought 320 acres of land near Crowley and cultivated rice using the providence method

(R.J. 16 [6], p. 6; R.J. 25 [5], p. 11). His activities over the next forty years contributed greatly to the culture of rice in the South, placing his name alongside that of Seaman A. Knapp as one of rice's most prominent pioneers.

He selected, improved, and distributed several new varieties. He first originated Number Seven in 1909 and distributed Blue Rose, Early Prolific, Louisiana Pearl, Edith, and Lady Wright in 1912, 1915, 1916, 1917, and 1920 respectively (R.J. 16 [6], p. 6; R.J. 25 [5], p.11). He selected the Blue Rose variety in 1907 from an unknown Japanese variety, which was found in J. F. Shoemaker's rice field near the Mermentau River of Jennings, Louisiana (Chambliss and Jenkins 1923, p. 13). The Blue Rose variety was the most famous among his varieties and was the leading variety in the South for about thirty years. His varieties accounted for 64 percent of the rice acreage of the United States in 1918 and for 80 percent of the U.S. rice acreage in 1920. In 1931, his varieties were grown on 93 percent of the southern rice acreage. In 1940, Louisiana rice farmers grew Blue Rose and Early Prolific on 82.5 percent of their rice acreage. The acreage planted with Blue Rose declined around 1945, largely because of its poor adaptability to combine harvesting and artificial drying.

E) Rice Varieties Developed at Rice Experiment Stations

From various parts of the world, a great number of rice varieties have been introduced into the United States during this century. The rice experiment stations (see Chapter VII) of the rice-producing states have selected varieties from the imported mixture of varieties, and improved and distributed them for commercial rice growing. Owing to the fact that they were selectively bred for specific characteristics, varieties developed at the rice experiment stations soon came to be preferred. By 1948, the Experiment Station rice already accounted for about 90 percent of the total rice production in the South.

E-1) Rice Experiment Station at Crowley, Louisiana

1. Fortuna was selected in 1911 from the Pa Chiam variety, which was obtained in 1905 from Formosa [Taiwan] by the U.S. Department of Agriculture. Fortuna was distributed for commercial growing in 1918 (R.J. 27 [6], p. 14). Texas Fortuna, selected in 1912 at Texas Branch Experiment Station at Beaumont, was distributed in 1925.

2. Acadia was selected in 1911 from the Omachi variety, which was imported from Japan by a rice farmer of Crowley. Acadia was distributed in Louisiana in 1918 (R.J. 27 [6], p. 14; Chambliss and Jenkins 1923, p. 6).

3. Delitus was selected in 1911 from the Bertone variety, which was introduced from France by the U.S. Department of Agriculture in 1904. The variety was

distributed for commercial growing in 1918 (Chambliss and Jenkins 1923, p. 7).

4. Tokalan, Evangeline, Vintula, and Salvo were also selected in 1911 by Charles E. Chambliss and J. Mitchell Jenkins at the Crowley station and distributed in 1918 for commercial growing. These four varieties were originated from imported varieties from the Philippines, Guatemala, Ceylon, and Java (Chambliss and Jenkins 1923, pp. 8-11).

5. Rexoro was selected in 1926 from the Marong-paroc variety brought in from the Philippines in 1911 by the U.S. Department of Agriculture. Rexoro was distributed in 1928 for commercial growing. It was grown only in Louisiana and Texas where the growing season is relatively long (R.J. 45 [6], p. 1).

6. Shoemed, Nira, and Iola were selected in 1928 from the rice seed introduced from the Philippine Islands in 1916 by the U.S. Department of Agriculture. They were distributed in 1931 and 1932.

7. Magnolia was selected from a cross of Improved Blue Rose and Fortuna in 1928 at the Rice Experiment Station at Briggs, California. The Rice Experiment Station at Crowley improved and distributed the selection (R.J. 50 [11], p. 13). In 1946, Magnolia was seeded on 901 acres in Louisiana; in 1947, on 22,275 acres in the state. By 1956, 47,318 acres [about 10 percent of the state rice acreage] were devoted to Magnolia.

8. The Sunbonnet variety, selected from Bluebonnet [a selection from a cross between Rexoro and Fortuna], was released through the Louisiana Seed Rice Growers Association in the spring of 1953 (R.J. June 1960, p. 16).

9. Toro was selected and bred from a cross of three outstanding varieties: Rexoro, Fortuna, and Blue Rose. It was released in the early 1950s. By 1957, Toro was planted on about 1.7 million acres [16 percent of the rice acreage] in Louisiana.

10. Nato, a medium-grain variety, was released in 1952 (R.J. May 1957, p. 34). By 1966, about 30 percent of all the rice acreage in the South was devoted to this variety. It was the leading variety in the South during the years from 1962 through 1967.

11. Vista and Della were released in the spring of 1971. Vista, a medium-grain variety, has a growing season of about 125 days, one week earlier than Saturn. The Vista variety was one of the best varieties for second cutting, but never planted on more than 10 percent of Louisiana acreage. Della was a scented variety and never gained popularity (R.J. April 1971, p. 30).

E-2) Rice Branch Station at Stuttgart, Arkansas

In 1931, more than one hundred new varieties of rice, brought in from foreign countries and from other parts of the United states, were planted on the rice land of the

Arkansas Branch Experiment Station at Stuttgart (R.J. 34 [11], p. 20).

1. Zenith, an early-maturing medium-grain variety, selected from Blue Rose in 1930 by Glenk K. Alter near DeWitt, Arkansas, was released in 1936 by the station. The variety matured in the same days [about 126 days] with Early Prolific, but yielded slightly higher. The kernels were a little smaller than those of Early Prolific and of better milling quality (R.J. 39 [12], p. 5). For more than ten years, from 1943 through 1955, Zenith accounted for about forty or fifty percent of the rice acreage in Arkansas.

2. Arkansas Fortuna, Prelude, Arkrose, and Kamrose were released to the growers in 1939, 1941, 1941, and 1943 respectively. Prelude was sown in 1946 on 23 percent of Arkansas rice acreage (R.J. 48 [4], pp. 3-4).

3. Rexark was a cross between Rexoro and Supreme Blue Rose. The cross was originally made in 1932 at the Texas Branch Experiment Station at Beaumont. Rexark was a medium-early maturing, long-slender grain variety. It was introduced in the Stuttgart Branch Station in 1937 and released in 1947 by the station (R.J. 51 [2], pp. 25-26). By 1951, it was grown on the 9.3 percent of Arkansas rice acreage.

4. Nova, an early-maturing variety with medium grain, was tested from 1958 through 1962 and was released in the spring of 1963.

5. Starbonnet, a long-grain variety, was released to growers in 1967. It was developed from a cross between Century Patna 231 and Bluebonnet (R.F. January 1967, p. 13). Starbonnet was the leading variety in Arkansas for sixteen years, from 1969 until 1984, and also was one of the principal varieties in the South during the same period.

6. Bonnet 73, a long-grain variety, was first released in 1973 to qualified growers for production of registered seed. It was a F_3 descendant from a cross between Bluebonnet 50 and other two unnamed varieties. In 1975, it accounted for 5.2 percent of Arkansas rice production.

7. Newbonnet and Bond, two long-grain varieties, were commercially released to growers in the spring of the year 1983. Bond, a short-stature, long-grain variety, matures as early as Labelle. Bond was grown on 5.6 percent of the 1985 rice acreage in Arkansas (Appendix VI). Newbonnet was derived from a cross of Dawn/Bonnet 73 made at Stuttgart in 1968 and was first tested in 1975. It is a high-yielding, short-stature rice. The Newbonnet has been the leading variety in Arkansas since 1985 (R.J. May 1986, p. 10; Appendix VI).

8. Tebonnet, an early-maturing, long-grain variety, was released in 1985, after it had been tested for five years from 1979 to 1983 in the rice-growing areas of Arkansas, Mississippi, and Louisiana. The Arkansas acreage planted with this variety gradually has increased from 1985

to the present year [1987]. In 1987, it was grown on 13.2 percent of the Arkansas rice acreage.

E-3) Rice Experiment Station at Beaumont, Texas

1. Bluebonnet, a relatively early-maturing variety with long and slender grain, was developed from a cross between Rexoro and Fortuna made at the Rice Experiment Station at Beaumont, Texas (R.J. 49 [7], p. 16; R.J. 54 [2], p. 17). Bluebonnet was sown for the first time on about 6,800 acres of Texas farms in 1945 and on about 40,300 acres of Texas farms in 1946. By 1961, this variety accounted for 46 percent of the rice acreage in the South. In 1969, Blubonnet was replaced with Bluebelle for the leading long-grain variety in the South.

2. Century Patna, distributed in 1950, became the leading variety in Texas in 1953 and kept this position until 1957. In 1954, it was sown on more than 0.3 million acres in the South.

3. Belle Patna, a very-early-maturing [about 102 days], long-grain variety, was released commercially in 1961 to Texas rice growers. In 1962, Belle Patna was grown on 19.0 percent of Texas rice acreage, but the variety was responsible for 27.0 percent of the state rice production. By 1965, it accounted for 64.1 percent of Texas rice acreage, and the production of the variety reached 66.3 percent of the state annual output. It was rated as the

best variety for a second crop [ratoon crop] along the Gulf Coast Prairies until it was replaced with Labelle in 1973 (Figure V-2; Appendix VII).

4. Bluebelle, a very-early-maturing [about 107 days in Texas and 109 days in Louisiana], long-grain variety, was released in the spring of 1965. By 1968, about 25 percent of the total rice acreage in the South was planted with Bluebelle.

5. Labelle, an early-maturing variety with long-grain, was released in the spring of 1972 (R.J. July 1972, p. 52 and p. 58). It became a popular variety for second harvest. By 1979, this variety was grown on 93.6 percent of the total Texas rice acreage. In 1984, it was still the leading variety along the Gulf Coast Prairies (Figure V-3; Appendix VIII).

Besides the two varieties of Belle Patna and Labelle, other varieties such as Nato, Gulfrose, Bluebelle, Saturn, and Dawn could produce a good second crop. But the length of time required for maturity reduced its chance (R.F. February 1968, p. 12). Recently, Lemont is rated as the best variety for a second harvest.

6. Brazos, a medium-grain variety, was released in 1974. It was developed from a cross between Nova and an experimental cross, C.I.9545. It was never grown on more than 2 percent of the total rice acreage in the South.

7. Lebonnet, a long-grain variety, which was developed

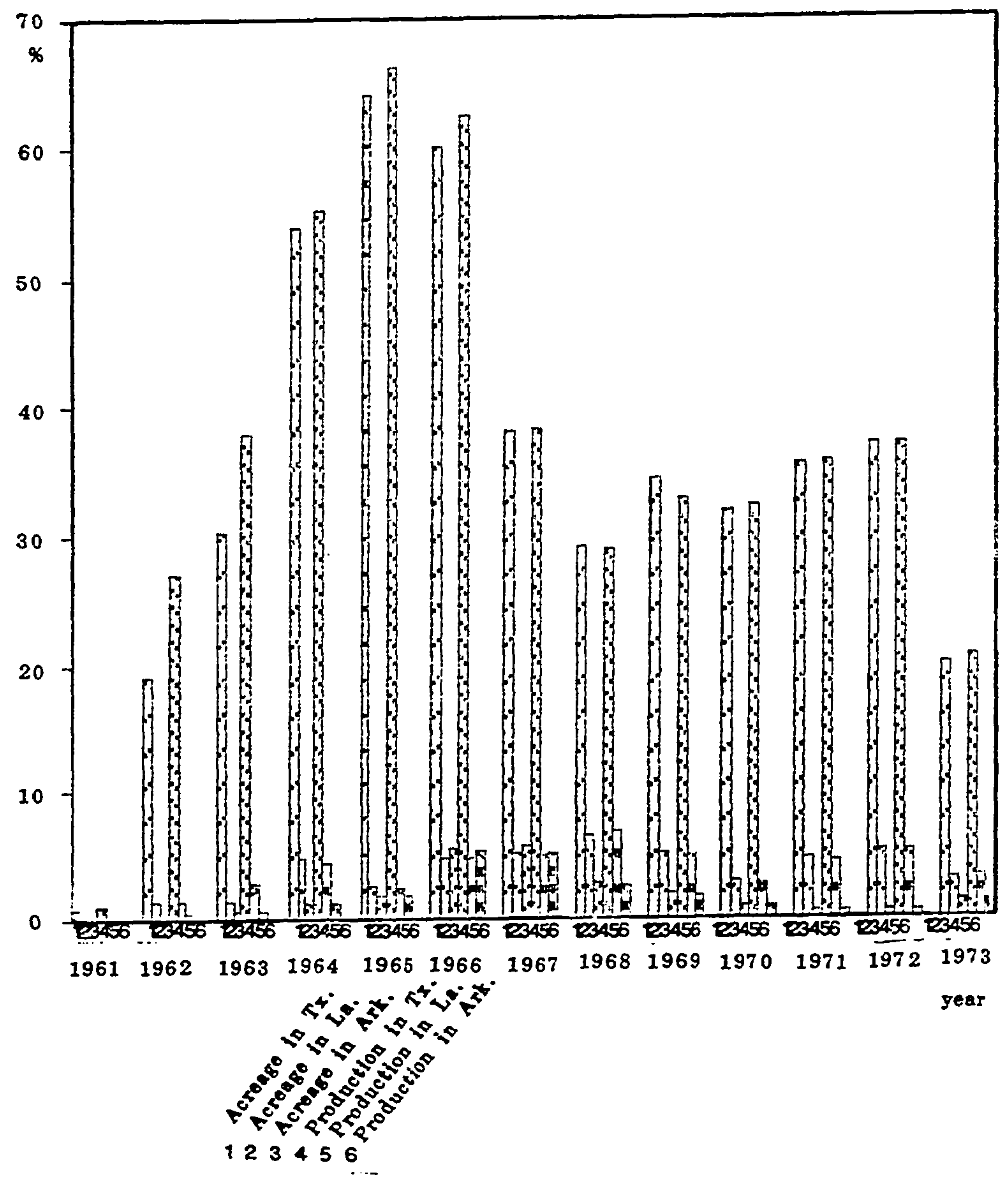

Figure V-2. The Percentages of Bella Patna Acreage and the Percentages of Bella Patna Production of the State Total in Texas, in Louisiana, and in Arkansas (Annual Reports of Rice Millers Association).

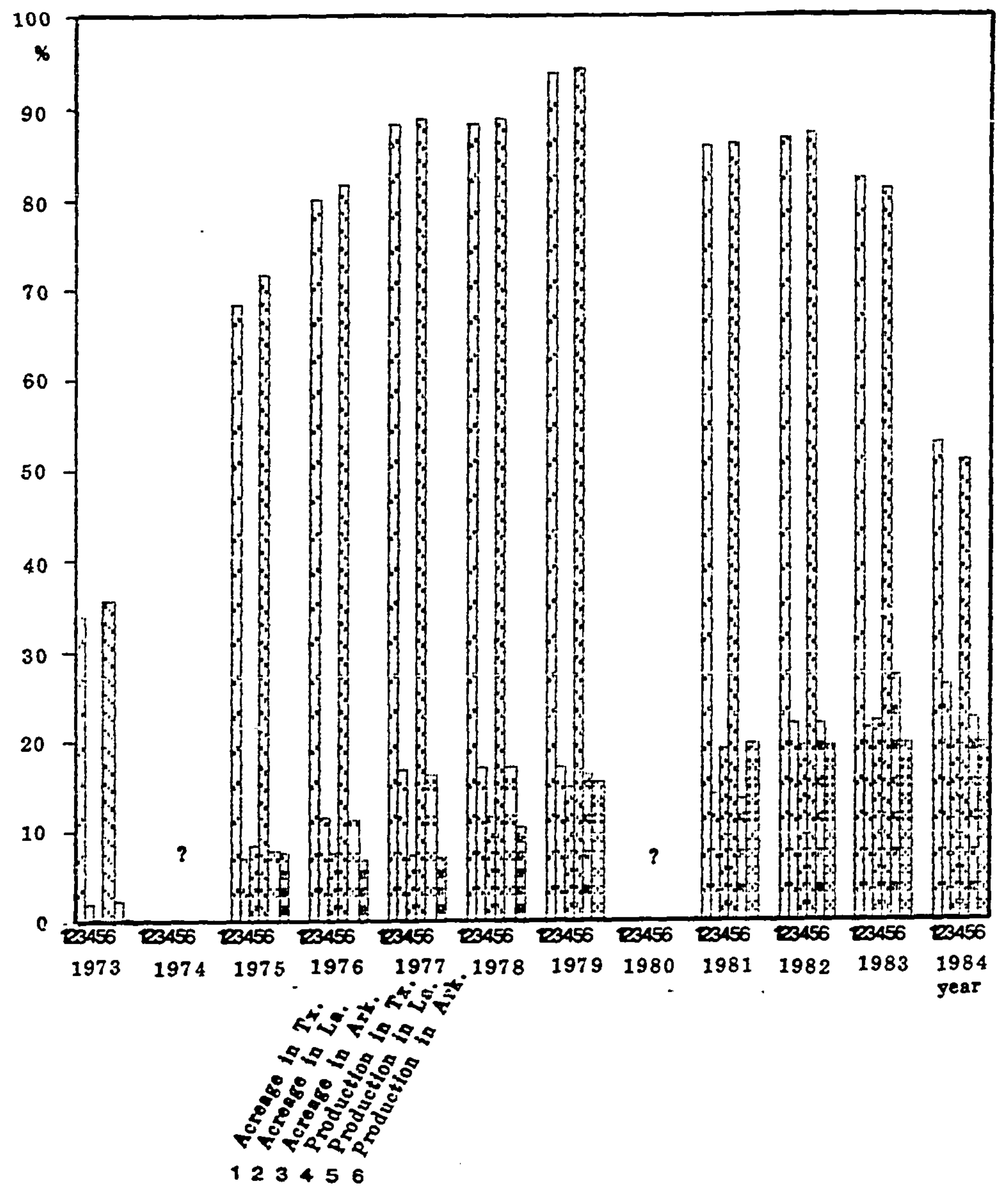

Figure V-3. The Percentages of Labelle Acreage and the Percentages of Labelle Production of the State Total in Texas, in Louisiana, and in Arkansas (Annual Reports of Rice Millers Association).

from a cross of Bluebelle with Beaumont Cross B6616A [Belle Patna and Dawn] was released in 1974. Lebonnet was grown on only 10 percent of Texas rice acreage in 1975, and after then, the acreage planted with the variety declined. However, it became a popular variety in Arkansas. It was grown on about 20 to 35 percent of Arkansas rice acreage in the years from 1976 through 1984.

8. Bellemont, a short-stature, lodging-resistant variety, was released for the Texas rice farmers in 1981. The variety was developed from Labelle, Lebonnet, Lebonnet, Bluebelle, Belle Patna, Dawn, and a semi-dwarf from Formosa [Taiwan]. The variety is only 33 inches high, 10 to 12 inches shorter than any other variety in the South. In 1984, it was grown on 6.9 percent of the Texas rice acreage.

9. Lemont is a semi-dwarf, early-maturing, long-grain variety. It was developed in 1974 at the Beaumont station. It was sown on an insignificant acres of rice land until 1983, but in 1984 Lemont was sown on 35 percent of the state rice acreage. Lemont is 5 centimeters taller than Bellemont and 25 centimeters shorter than Labelle.

The preceding enumeration is but a partial list of the rice varieties that have flourished in southern rice fields. From this, one gains some idea of the enormous effort that goes into plant breeding, the rapid introduction of new strains, and the dynamic nature of the industry. However, further research is needed to determine the subtle effects of geographical factors, such as soil, hydrology, climate, and disease, all of which differ in their effects upon rice culture.

CHAPTER VI

CROP ROTATION, FERTILIZATION, CRAWFISH RAISING, AND WEED, INSECT, AND BIRD CONTROL

A) Crop Combination and Crop Rotation

Continuous cultivation of any crop on the same land depletes soil fertility, and rice is no exception. From the early days of rice culture on the prairies in the South, rice growers recognized the advantages of rotation of rice fields with other land uses.

As early as 1901, Seaman A. Knapp suggested that, to enhance profits, Gulf Coast rice farmers raise crops such as sugarcane, corn, fruits, and flowers, as well as domestic animals such as cows, hogs, horses, and mules. He advised them not to specialize in one crop [i.e., rice] on the grounds of economic safety (Knapp 1901, p. 1).

> It is neither safe nor economic farming to produce only one crop and buy everything else, necessary to supply of the farm. One crop farming is opposed to nature. The soils prefers a change and produces better under a rotation of crops. Safety and economy lie in producing as many of the things demanded for the farm consumption as possible.

In 1911, G. T. Surface (1911, p. 509) also commented on the soil exploitation of rice growing and the feasibility of rotation with legumes.

An acre of rice producing 33 bushels [1,485 pounds] removes from the soil 16 pounds of phosphoric acid, 42 pounds of potash, and about 60 pounds of nitrogen. To replace this by the purchase of commercial fertilizers would cost 15 to 18 dollars per acre, which is prohibitive tax on the industry at present prices. The potash is largely returned to the land if the straw is not removed and the nitrogen must be maintained by stock feeding and by rotating with legumes such as cowpeas, beans, vetches, peanuts, and cloves which have the power of gathering nitrogen from the air.

The Rice Journal and the Rice Farming continuously commented on the rotation practices in the southern rice-producing regions, in which some producers grew rice in alternative years, others once in three years, or twice in three years, or less frequently, once in four years. The exact rotation methods depended not only upon land characteristics, such as soil productivity, but also upon how much rice the landowner decided to grow in a given year. The rotation of rice with lespedeza[1], clover[2], soybeans[3],

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1 Lespedeza, sometimes referred to as "the clover of the southland," goes by its genus name, *Lespedeza*, of which there are many species: *Lespedeza stipulacea* L.; *L. striata* L.; *L. pocumbens* L.; *L. repens* L.; *L. bicolor* L.; *L. virginia* L.; *L. stuevei* L.; *L. violacea* L.; *L. intermedia* L.; *L. nutlallii* L.; *L. cuneata* L.; *L. hirta* L.; *L. capitala* L.; and *L. angustrifolia* L.

2 The genus of clover, *Trifolium*, is classified into such species as *Trifolium resupinatum* L.; *T. lappaceum* L.; *T. arvense* L.; and *T. incarnatum* L.

3 *Glycine max* (L.) Merill

oats[4], sorghums[5], or wheat[6] were frequently pointed out as recommended rotation schemes for southern rice farms.

The soybean is a latecomer to American agriculture. Although introduced from Asia much earlier, it was not notable as a crop until the 1930s. In the South, soybean acreage did not increase to a significant amount until after World War Two. The crop became popular as a rotational or replacement crop with cotton in the Mississippi River lowlands of Arkansas, Mississippi, and Louisiana in the 1950s, and a decade later had invaded the Gulf Coast Prairies.

Paul Wessels, a tenant-operator on a 760 acre-farm on the Grand Prairie, began growing soybeans in 1938, but it was not until 1953, when he planted 612 acres of soybeans, that he harvested the crop with a noticeable profit (R.J. 56 [11], pp. 17-18). Even after soybeans were grown in southern rice regions, they were not, at first, considered a proper rotation crop with rice, despite knowledge of its value as a legume. In 1961, Ward McCown, a Jefferson County rice farmer, who had grown soybeans in the Texas rice belt, stressed flexibility in the soybean harvesting program (R.J. January 1961 p. 6).

My practice is to market the beans when I have

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4 *Avena sativa* L.

5 *Sorghum vulgare* Persoon

6 *Triticum aestivum* L.

> satisfactory yields and favorable weather conditions. Otherwise, I will either bale the crop for hay or turn the cattle into the field to graze it.... My rice and soybean operations are completely separate from each other. I never uses a rice-soybean rotation. The tight layer of clay found in the rice soil is too close to the surface to facilitate good internal drainage, a necessity for soybeans.

The Rice Journal reported in 1963 that the soybean crop was being called "Cinderella crop" in the rice belt in southwestern Louisiana (R.J. October 1963, p.8). In 1965, Fred Rogers, manager of the Nelson Rogers farm at Stuttgart, planted 100 acres of rice, 60 acres of oats double-cropped with soybeans, 207 acres of soybeans, and about 60 acres of lespedeza (R.J. April 1965, p. 28). Gradually, the advantages of a rice-soybean rotation became recognized and since the mid-1960s the rice-soybean rotation has become the most common type of crop rotation in the southern rice-producing regions. The soybean acreage in the thirteen rice-producing parishes in Louisiana increased from 45,000 acres in 1965 to 425,000 acres in 1970 (R.J. February 1971, p. 13).

Soybeans certainly complement rice in the use of land, labor, and machinery. As a leguminous crop, soybeans have the ability to gather nitrogen of the air and increases soil fertility. Both the yield and quality of rice can be improved when rice is rotated with soybeans. Moreover, soybeans are planted after the peak of labor in planting rice is over, and they are harvested when rice harvest is nearly completed. They serve as a clean-up crop for red rice, a troublesome and unwanted weed throughout the rice farms in the South.

Historically, beef cattle have been very important in southeastern Texas. In the western portion of the Texas rice belt, beef cattle are still far more important than rice, though rice and cattle are often produced on the same farms. In the eastern portion of the Texas rice belt, the dominant rotation method has become a rice-soybean rotation as in other southern rice-producing areas; in the western portion of Texas rice belt, a rice-sorghum rotation has become the most typical crop rotation scheme primarily because soybeans do not grow well on the area's sandy soil.

The Yazoo Basin is most noted for cotton production, but in recent years it has seen dramatic increases in the acreages of both soybeans and rice. The former is serving as a replacement for cotton, whereas the latter is grown on distinctly different sites. Cotton is grown on sandy loams, while rice is grown on the buckshot soils.[7] Rotation of rice with cotton has been rarely practiced, but rice-soybean rotation is quite common.

B) Livestock and Rice

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7 The dark-colored clay, found in the Yazoo Basin, has been locally called "buckshot soil." The buckshot soil afforded very low crop yields before rice was introduced into this land. Cotton does not grow well on the buckshot soil.

Cattle raising was an important enterprise on the Gulf Coast Prairies and on the Grand Prairie long before large-scale, commercial rice culture was introduced. Even in the early years, rice was rotated with pasture; therefore, cattle raising remained an important industry. Around the turn of this century, P. S. Lovell, a Gulf Coastal farmer, grew rice on land two or three years, and then pastured it for a like period, recognizing that stock raising on the land could enhance yields of high grade rice (R.J. 6 [7], p. 1). In 1901, Seaman Knapp recommended that rice farmers raise cattle on the grounds that they could consume materials that would otherwise be wasted: the rice straw and the after-growth of the rice fields in the fall. He also recommended the raising of swine because hogs, natural scavengers, could be fed with the variety of root crops, leguminous plants, and other grasses that were produced naturally in the South. Horses and mules, indispensable for the field work in those days, were also recommended as rice-field grazers (Knapp 1901, p. 1).

As soybeans became an important crop in the Gulf Coast Prairies in the mid-1960s, many rice farmers of the region turned from livestock raising to use the land for soybean production. Cattle raising, however, is still an important enterprise in the western portion of the Texas rice belt. In southwestern Louisiana, some rice farmers continue the traditional practice of rotating land from rice to pasture and raising cattle on the pasture.

C) <u>Crawfish on the Rice Fields</u>

Some rice farmers in the South have tried successfully to breed fish on their farms. They have kept water in reservoirs, grown carp and catfish in them over the winter and the early spring, and then used the water for irrigation during the field-flooding season. However, fish require water up to four feet in depth, and do not grow well in rice fields. Thus fish breeding is not as commonly associated with rice growing as crawfish raising.

The crawfish, which may be called crayfish, have been in abundance in Louisiana for centuries, served as delicious dishes such as bisque, crawfish stew, etoufee, and boiled crawfish. More than one hundred species of crawfish are known in the United States and twenty-nine species are found in Louisiana alone. Of the species inhabiting in Louisiana, only two, red swamp crawfish[8] and white river crawfish[9], are sufficiently abundant to be consumed for food in Louisiana, the former being by far the most common (LaCaze 1970, pp. 2-3).

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8 <u>Procambarus clarkii</u>

9 <u>Procambarus blandingi acutus</u>

Crawfish raising in rice fields was practiced in southwestern Louisiana in the 1950s for the purpose of making extra money by charging urban dwellers for the privilege of fishing in their rice fields. After the USDA's Soil Conservation Service developed crawfish raising technique in 1959, crawfish growing became consistently profitable. In the spring of 1960, Eugene Van Geffen, a Louisiana rice farmer north of Lake Arthur, raised crawfish on 80 acres of his land, and harvested from 1,500 to 2,000 pounds of crawfish per acre, who sold for 35 cents per pound in 1960 (Sonnier 1960, p. 8). During the 1963 season, southwestern Louisiana rice farmers produced $350,000 worth of crawfish[10] (Sonnier 1960, p. 8; R.J. January 1964, p. 22).

In the eastern portion of the Texas rice belt, crawfish raising on a commercial basis was begun by Elden Gains, a Beaumont rice farmer, in 1965. Despite such successes, crawfish raising remains a minor industry in this area, and, for the most part, crawfish raising and rice farming are separate enterprises.

Crawfish can be raised in ponds (crawfish open ponds) designed for that purpose exclusively, or can be rotated with rice (Figure VI-1) or soybeans, or crawfish can be raised in conjunction with rice in the same fields. The crawfish open ponds are similar to rice fields, but the only

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10 The fishermen in the Atchafalaya swamp in southern Louisiana caught crawfish worth of $900,000 during the 1963 season.

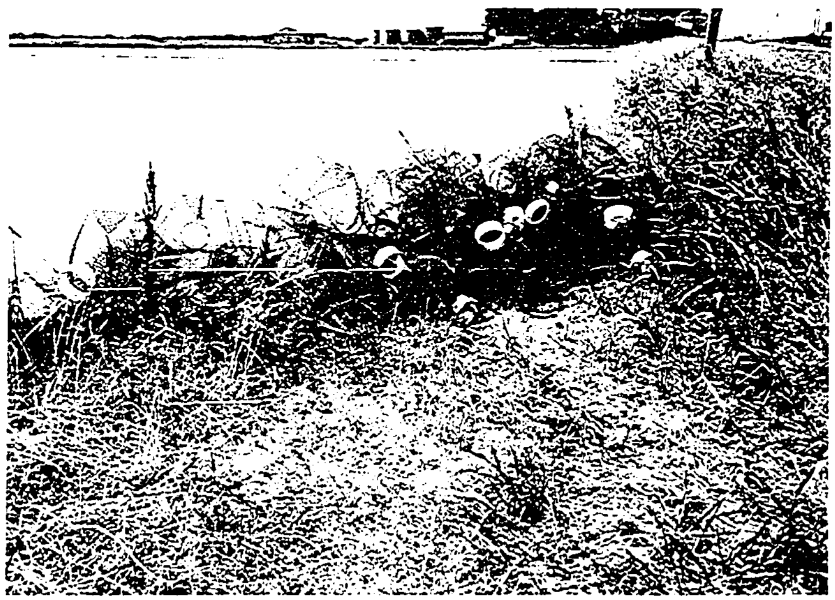

Figure VI-1. Crawfish-traps on the Levee of a Rice Field rear Crowley, Louisiana (Photo Taken by the Author on May 18, 1988).

crop is crawfish. A crawfish pond is best with a water depth of 20-30 inches. Therefore, a rice farmer who wishes to raise crawfish find it necessary to raise the levees of his field in order to hold the greater depth (LaCaze 1970, pp. 6-7). Crawfish feed well on the decaying rice plants and microorganism in the flooded rice fields (R.F. February 1984, p. 22).

The bulk of crawfish sold in markets has come from the Atchafalaya Basin, with St. Martin Parish being the most important source. In 1970, more than 6 million pounds of crawfish were harvested in Louisiana; that year, fifty-five producers in St. Martin Parish were engaged in crawfish raising in ponds occupying 10,000 acres (Gauthier 1970, p. 14). In 1973, there were about 44,000 acres of managed crawfish ponds in south Louisiana (Gary 1974, p. iii). The amount harvested increased annually, and by 1983 it was approximately 20 million pounds. In 1984, Louisiana had nearly 100,000 acres of managed crawfish ponds (Moody 1985, p.2). Unfortunately, more detailed data are not available on the production and acreage of the crawfish rotated with rice or cultured in rice fields in southwestern Louisiana.

D) Weed Control

Weeds often determine the number of years in which land is kept continuously in rice. The conditions under which rice is grown also favor aquatic and semi-aquatic weeds. The worst of them is red rice[11], an inferior type of rice. The loss to southern rice farmers from the effects of red rice is estimated at about 50 million dollars in a year (R.J. march 1988, p. 6). Barn-yard grass[12] is also one of the most troublesome weeds in the southern rice fields. Other weeds in the southern rice fields frequently listed in the Rice Journal and the Rice farming are false indigo[13], alligator weed[14], water parsley[15], dayflower[16], and several species of sedges[17].

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11 Red rice is included in the same species with commercial rice [Oryza sativa L.].

12 Echinochloa crusgalli (L.) Beauvois.

13 The genus of false indigo [Baptisia] are classified into several species: Baptisia australis (L.) R.Br.; B. monor (Lehm.) Fern; B. leucophaea Nutt; B. leucantha T. & G.; B. sphaerocarpa Nutt.

14 Alternanthera philoxeroides (Martius) Grisebach.

15 Sium suave Walter f.

16 Five species are found in the South. They are Commelina virginica L.; C. erecta L.; C. communis L.; C. diffusa Burman f.; and C. caroliniana Walter.

17 There are dozens of different genera of sedges [Cyperaceae] found in the South. They are Cyperus L.; Dulichium Richard ex. Persoon; Eleocharis R. Brown; Dichromena Michaux; Psilocarya Torrey; Bulbostylis Kunth; Fimbristylis Vahl; Scripus L.; Eriophorum L.; Fuirena Rottboell; Hemicarpha Nees & Arnott; Lipocarpha R. Brown; Rhynchospora Vahl; Cladium P. Browne; Scleria Bergius; Cymophyllus Mackenzie; and Carex L.

The rice growers in the South Atlantic Hearth recorded the red rice problems. They believed that red rice was derived from the deterioration of the popular rice varieties. The deterioration of the grain, Allston (1846, p. 327) believed, arose "from utter neglect and exposure of the seed to the vicissitudes of weather from year to year," or from being "covered so deep in either earth or water as not to have vegetated for years." The red rice was sometimes used as horse and poultry feed in the South Atlantic Hearth (Allston 1846, p. 327). Red rice was also reported as a problem in the late nineteenth century in Louisiana and in the early twentieth century in Arkansas when rice culture on a large-scale, commercial basis began.

Red rice is usually distributed through the use of seed rice containing the seed of red rice (Chambliss 1920, p. 22). It has been also spread from rice field to rice field by shared mechanical equipment. The most effective way in controlling red rice is to plant rice seed free from red rice and to rotate rice with other crops. In addition, the following cultural practices may be effective (R.J. March 1988, p. 9):

> (1) Keeping rice fields wet and rolling straw after harvest promotes germination of red rice so that it can be killed by frost before heading; (2) Flooding fields encourages use by ducks, which eat large quantities of red rice seed; (3) Early spring cultivation and harrowing stimulate red rice germination and may allow the mechanical destruction of several flushes of red rice before planting rice or rotational crops, such as soybeans; (4) Land leveling and filling of potholes eliminate perennial sources of

red rice seed; and (5) Delaying of planting dates allows much more time for germination and destruction of red rice with land preparation equipment.

Southern rice farmers practiced hand weeding for a long time. However, it became increasingly too expensive and tedious as the farming scale grew larger. In 1910, Knapp recommended "summer fallowing with shallow plowing and the employment of some densely growing crop like cowpeas or velvet beans" for the best weed control (Knapp 1910, pp. 18-19). Hand pulling, mowing, summer cultivation, and pasturing were the best means for controlling red rice, barnyard grass, and other weeds until around World War Two, when herbicides began to be applied to the rice fields. Today, herbicides are widely used to control a variety of undesirable weeds.

E) Insect, Muskrat, and Bird Control

Insects have troubled rice farmers since the earliest times. Some attack the stem and blades, some feed on the roots, and some go directly for the grain itself. Sucking insects puncture the rice kernel with their long, slender beaks. Among the sucking insects, the rice stinkbug[18] is the most common, and, in Texas, the most damaging pest in rice fields (R.J. April 1988, p. 12; Figure VI-2). The rice water-weevil,[19] known as the rice root-maggot in its larval

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18 *Oebalus pugnax* (Fabr.).

19 *Lissorboptrus orysophilus* Kuschel.

stage, attack the roots of rice plant, retarding the development of the plant by limiting the plant's ability to absorb nutrients (Figure VI-2). Leaf scarring is done by adult water-weevils, but such damage rarely causes economic losses. In Louisiana, the rice water-weevil is the most serious pest. The total annual loss in the state from this pest is estimated at between $9 million and $10 million (R.J. April 1988, p. 12). In 1934, two entomologists, Isley and Schwardt, published instructions on how to control water weevil. They found that the larvae could be controlled appreciably by the time and methods of flooding and draining (drying) rice fields (Rolston 1965 p. 50).

The larvae of the sugarcane borer[20] and the rice stalk borer[21] often attack the stems of rice plants, weakening or breaking the plants (Jones and others 1952, p. 25-26; Chambliss 1920, p. 24). The grape colaspis (lespedeza worm) at its larval stage feeds on germinating rice seed and causes damage by reducing rice stand (R.J. February 1962, p. 17). As might be expected, rice following lespedeza or pasture tends to suffer more damage from this pest (R.J.

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20 Diatreaea saccharalis (F.).

21 Chilo plejadellus Zincken.

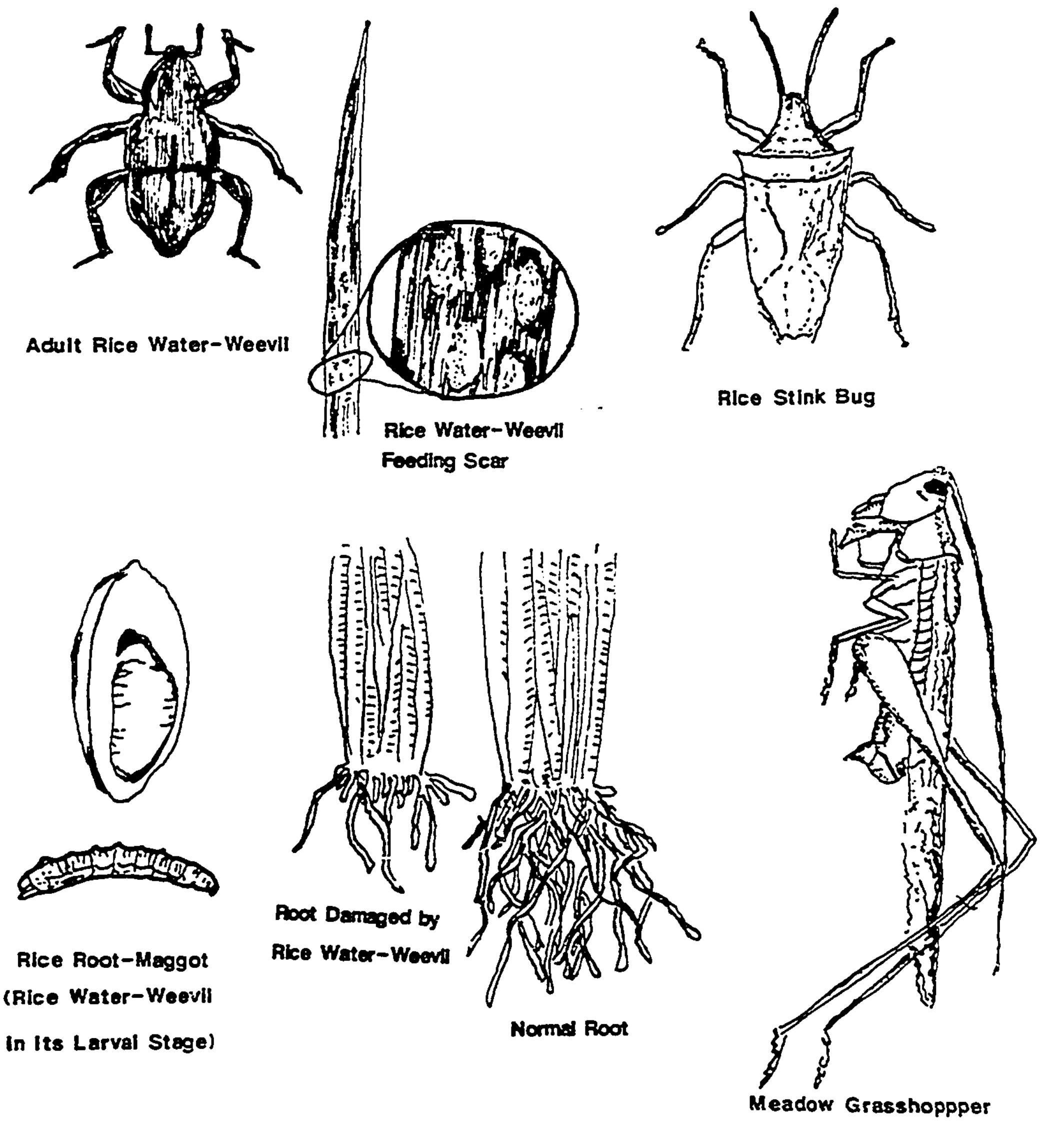

Figure VI-2. Rice Water-Weevil, Rice Stink Bug, and Grasshopper (Redrawn from: Cooperative Extension Service of University of Arkansas 1988, Leaflet EL 330).

February 1961, p. 6). Grasshoppers[22] do damage on the leaves and stalks of rice plants.

The battle against insects is never won, but losses can be reduced by judicious application of insecticides. One method of application is to treat the seed rice. Aldrin-treated seed effectively control two insects, the grape colaspis and the rice water-weevil. Apparently, it has been effective, for aldrin-treated rice accounted for two-thirds of all rice planted in Arkansas in 1961, only two years after its introduction (R.J. February 1962, p. 17). In 1975, P. W. Douglas, a Texas rice farmer who planted 400 acres of rice near Beaumont, was practicing insect control by applying the following insecticides (R.F. April 1975, pp. 15-16):

> Root maggot control is achieved with the use of 17 pounds of Furaden per acre. Furaden is also used in the reservoirs to control mosquito larvae without harming the fish. Stinkbugs are controlled by spraying with two pints of Magnum 44 per acre around the edge of the fields.

Not surprisingly, insecticide application varies greatly from area to area. The more detailed applications of insecticides, about which data are not available, are not included in this study.

Muskrat,[23] a mammal native to America and common in

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22 Two species of grasshoppers are most notable: meadow grasshopper [*Conocephalus fasciatus* (DeGeer)] and differential grasshopper [*Melanoplus differentialis* (Thomas)].

23 *Ondatra zibethica*.

most of the United States, is notorious for its damage to rice farming. In the rice-producing areas, the still or slow-moving water of ditches, reservoirs, and streams provides an ideal habitat for the muskrat. Although rice is not their preferred food, muskrats eat a great deal of rice during the summer months. Moreover, they dig into levees, forcing rice farmers to spend time and labor in repairing them. Surveys indicated that muskrat damage within the rice-growing areas in Arkansas was $800,426 in 1966, $892,455 in 1967, and nearly $1,000,000 in 1971. A number of methods have been employed to control muskrats. Dogs have been trained to reduce their numbers; toxic baits occasionally have been used; but perhaps more effective is trapping (R.F. February 1972, pp. 8-10).

Even more damaging to crop yields are the myriad birds that feed directly off the ripe grains. Birds were serious pests during the early years; the South Atlantic Hearth was on the major migratory route of the bololink,[24] which consumed ripening rice on its way south during the fall (Meanley 1971, p. 1). Similarly, the rice culture in southern Louisiana along the Mississippi River was also seriously troubled with blackbirds[25] (*DeBow's Review* 1856,

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24 *Dolichnyx oryzivorus*.

25 Blackbird is a generic term denoting color, but it usually includes any of several species that are colored black. Often, flocks contain individuals of several species, the most common being the redwing blackbird [*Ageliaus phoenieus*], boat-tailored grackles [*Cassidix*

p.291). The rice fields of the Gulf Coast Prairies have been attacked by redwing blackbirds and boat-tailed grackles, which breed on the marshlands bordering the Gulf Coast Prairies. Blackbirds have also done serious damage to the rice crop in the Lower Mississippi River Valley, which is located on a large blackbird flyway (Meanley 1971, p. 1). In northeastern Arkansas, cowbirds, native to this area, have troubled rice farmers. In 1963, the loss of rice from the blackbirds in the single county of Poinsett in northeastern Arkansas was estimated at $524,000 (Cullins 1963, p. 13).

When rice was harvested with sickles or binders, harvested rice was shocked in the fields for ten days of two weeks before being threshed. The shocked rice was easily attacked by blackbirds. Bird losses were sharply reduced with the introduction of combines and driers for harvesting and drying, because rice was harvested as soon as it matured and because the harvested rice was immediately transported away from the rice fields.

A number of techniques have been employed to frighten blackbirds away from the fields. Firearms, firecrackers, and automatic gas exploders have been used to scare the blackbirds from the fields (Figure VI-3; Figure VI-4). Airplane patrols were tried as means of driving them away.

<u>mexicanus</u>], and cowbirds [<u>Molothrus</u> <u>ater</u>].

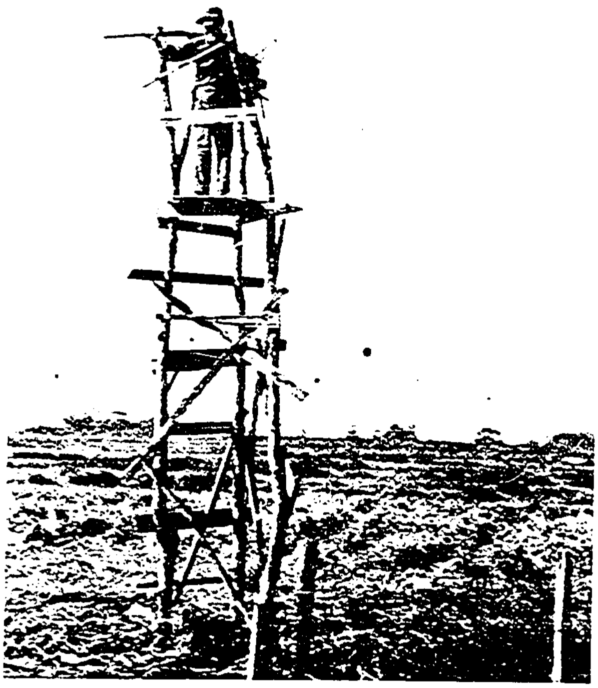

Figure VI-3. An Elevated Shooting Stand for Driving Away Blackbirds from Rice Fields (Meanley 1971, p. 47).

Figure VI-4. An Automatic Exploder for Driving Away Blackbirds from Rice Fields (Meanley 1971, p. 48).

Decoy traps (Figure VI-5) and light traps[26] have been operated as the most practical way for rice farmers to reduce blackbirds during the rice-ripening season. In the late summer of 1963, 20 large decoy traps were tested in Arkansas rice belt. About 40,000 blackbirds were trapped; the average catch was 39 birds per trap in a day. In January 1961, a light trap was operated in a single night to catch as many as about 120,000 starlings[27] and blackbirds at a small roost near Walnut Ridge, Arkansas. More than 10,000 birds were caught for three nights by light traps, which were operated near Judy Hill in Poinsett County in northeastern Arkansas on March 21, 22, and 26, 1962. Poison baits, roost bombing, and roost spraying have been tried but are considered undesirable because of the potential harm to other wildlife, domestic animals, or even people (Meanley 1971, pp. 40-61; Cullins 1963, p. 13). As is commonly the case, blackbirds do considerable damage during the rice-ripening season, but they prove beneficial during the growing season by eating weed seeds and harmful insects.

Wild ducks have been beneficial to rice farming in the South in that they eat a lot of red rice and other weed

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26 A light trap is operated during a night. Birds are attracted with lights and captured in traps.

27 _Sturus vulgaris_.

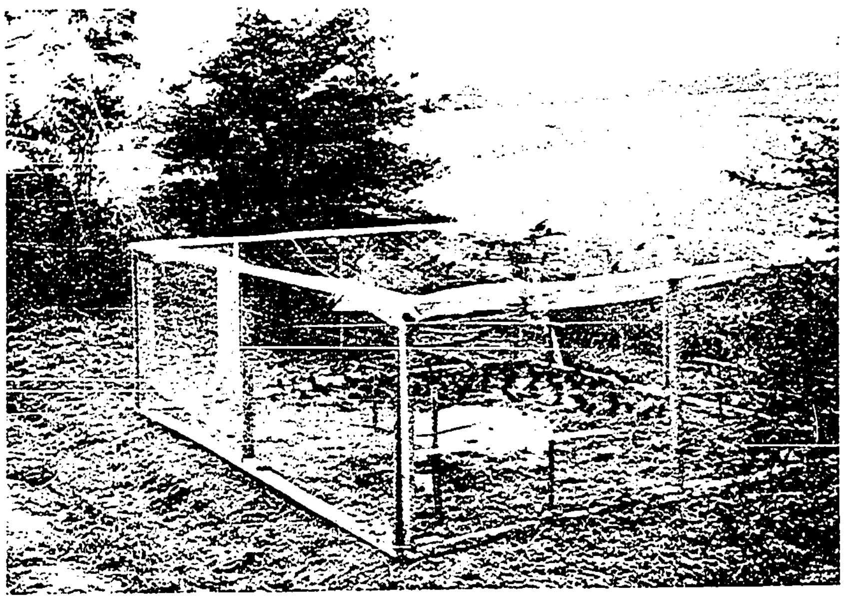

Figure VI-5. A Portable Decoy Traps, 16 by 18 Foot, Made of Poultry Wire Panels (Meanley 1971, p. 52).

seeds.[28] Rice growers can attract wild ducks by flooding fields, either by catching rainwater or by pumping water, in the fall and keeping them flooded over the winter. The flooded rice fields often have been managed for waterfowl hunting sites in winter (refer to Chapter III-E).

F) Fertilization

In 1901, Major G. Lee, Louisiana state commissioner of agriculture, lamented the absence of reliable data on the fertilizers for rice, arguing for the importance of fertilization in rice farming. Of the fifteen chemical elements necessary to secure successful plant production, he pointed out, nitrogen, potash, and phosphorus were the three elements that should be supplied in the form of fertilizers. He also urged rice farmers to grow rice in rotation with some leguminous crops for their renovating effect upon the soil (R.J. 3 [5], p. 10). Commercial fertilizers were recommended by Seaman Knapp in 1910. He also recommended such fertilizing methods as plowing under of the rice straw,

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28 Dr. Roy Smith, USDA agronomist at Stuttgart, and Jimmy Sullivan, wildlife specialist at Humphrey, conducted a test to determine how much rice, both white and red, was consumed by wild ducks during the winter of 1979-1980 in a flooded field in Arkansas County. Smith and Sullivan found that heavy duck feeding during the winter reduced the number of red rice and white rice grains on and in the soil by about 97 percent. The remaining 3 percent were buried seed.

fallowing, and using some renovating crop as a green manure (Knapp 1910, p. 16).

Depending on the soil types of rice lands, the amount of fertilizers applied per acre and the adequate combination of the three components of nitrogen, phosphorous, and potash have been varied (Jones and others 1952, p. 18). The techniques of fertilization have been different from rice farm to rice farm according to the season and weather, the different management practices, the diversity of soil, and the amount of time that the lands have been in use. The testimonies for successful fertilization are too varied to be included in this study.

G) Ratoon Crop: Second Rice Crop

On the Gulf Coast Prairies, an early-maturing rice variety can be harvested twice in a year without seeding twice. The ratooning of rice, the harvesting of a second rice crop, was widely adopted by Texas rice farmers only after Belle Patna, an early-maturing [95 to 105 days] variety, was released in 1961 to Texas rice growers (see Chapter V). Only 10 percent of the Texas rice acreage was being ratooned in 1961 and since then the percentage gradually has increased.

In ratooning, rice stubbles are normally cut with combines to about 17 inches high. From this height, the crop can grow quickly for a second harvest, although maturity may be uneven. Some farmers cut rice stubbles to less than 10 inches, or flatten (roll) them immediately after first harvest, with results of more uniform but delayed crop maturity.

A variety harvested by August 10th or 20th requires two-thirds to three-fourths of the original time for second crop maturity. This means 68 to 77 days for Belle Patna. Early frost becomes a hazard when the first harvest is late in August. The testimonies for the second harvest have varied from farm to farm. About one-third of the first crop normally was harvested into the second crop, but one-fifth or a half of the first crop was sometimes reported (R.F. June 1970, pp. 20-21; R.F. February 1976, p. 20).

Ratooning of rice has never proved to be practical on the rice-producing region along the Lower Mississippi River Valley of eastern Arkansas, Mississippi Yazoo Basin, northeastern Louisiana, and southeastern Missouri. In this region danger from frost precludes a possibility of profitable second harvest in most years. For this reason, ratooning of rice would be practical only after a variety could be developed that would mature in less than ninety days.

CHAPTER VII

RESEARCH INSTITUTES AND FARMERS ORGANIZATIONS

A) Rice Millers Association

Pioneers in the rice milling industry outside the South Atlantic Hearth were all located in New Orleans up to about 1892, the year when a group of rice growers met at Crowley, Louisiana, and decided to establish their own mill (R.J. 38 [12], p. 7; Ginn 1932, p. 32). By the turn of this century, a number of rice mills were already operating throughout the Gulf Coast Prairies of southwestern Louisiana and southeastern Texas. On May 5, 1902, a group of rice millers met together in order to discuss mutual concerns and they organized the first association, under the name of the Louisiana & Texas Rice Millers & Distributors Association. J. E. Broussard, the pioneer of rice milling in Texas, who erected and operated a rice mill at Beaumont, Texas, as early as in 1892, served as the association's first president. However, for the first several years the association held irregular meetings and lacked systematic programs (R.J. 20 [5], p. 32; Daniel 1985, p. 55).

By 1910, the rice milling industry in the South had grown so large that the rice millers required dependable statistics and information on the industry in the United States. On July 1, 1910, J. R. Leguenec, at that time working as a statistician for the U.S. Department of Agriculture, was employed as full-time secretary and statistician (R.J. 20 [5], p. 32; R.J. 38 [12], p. 7). Since that time, the association has furnished statistical data on the acreage, production, and distribution of rice. The data issued by the association have been regarded as the most accurate in the United States.

In 1912, the association's office was moved from Crowley, Louisiana, to Beaumont, Texas. In 1914, the association was reorganized under the name of Rice Millers Association, and in 1922 it was incorporated. The Rice Millers Association, as a nonstock, nonprofit association, has worked as a communication agency between the rice milling industry and legislators, USDA, rice growers, and the rice handlers throughout the United States. The annual meetings have been attended by millers, individual rice growers, rice handlers, and representatives from many organizations concerned with the rice industry or rice production.

B) Rice Marketing Organizations and Rice Cooperatives

Rice farmers organized cooperatives to market rice as early as 1890. A number of rice cooperatives were organized between 1910 and the early 1920s. These performed different functions for their members, most importantly marketing, drying, and milling. Recently, many cooperatives in the southern rice belts have formed hierarchical organizations: local cooperatives are often members of the central organizations.

By 1967, fifty-nine rice cooperatives were engaged in various functions of rice handling and rice marketing for their members in the South (Samuels 1968, pp. 9-10, 16-18). Of the fifty-nine southern rice cooperatives, four milled and warehoused rice, fifty-three were local driers, and the other two provided certain marketing functions for their members. Of these, twenty cooperatives were in Arkansas, eighteen each in Texas and in Louisiana, and the other three in Mississippi (Table VII-1). In Arkansas, rice farmers moved as much as 60 or 65 percent of their rice through cooperative mills during the 1966-1967 season. In Texas and in Louisiana, the percentages of the crop milled by cooperatives were 20 percent and 7 percent respectively (Samuels 1968, pp. 9-10, 16-18).

The success of rice cooperatives has been often affected by outside economic forces. In times of economic depression, bankruptcies or reorganizations soon followed.

Table VII-1. Number and Types of Rice Cooperatives in the United States in 1967

	US	South	Ark.	Tx.	La.	Miss.	Calif.
Total	65	59	(20	18	18	3)	6
Milling	6	4	(2	1	1	x)	2
Local drying and storage	57	53	(18	17	16	2)	4
Certain market-ing function	2	2	(x	x	1	1)	x
Share of crop milled by cooperatives			60 % to 65 %	20 % to 25 %	6 % to 8 %		80 % to 85 %

Source: Samuels 1968, p. 9.

B-1) Arkansas Rice Growers Cooperative Association: Riceland Foods

The Arkansas Rice Growers Cooperative Association was organized in 1921 as a rough rice marketing cooperative by B. E. Chaney, C. G. Miller, H. C. Stump, and E. B. Roy, and these men constituted its first officers. The association worked well for the first several years and yielded considerable profit for its membership of nearly one thousand rice growers (*R.J.* 33 [6], p. 16). But it began to meet serious difficulty in 1925 (*R.J.* 33 [6], p. 16).

> In 1925 came a slump in the price of rice, and the association decided to hold out for a better figure than any which had been offered. The hoped-for advance did not come, and a large portion of the crop of 1925 was carried in ware-houses for two years.... Many members of the association became dissatisfied, and after a long fight in the courts, many of them withdrew and their contracts were cancelled.

In January 1929, the remaining members reorganized the association completely. The Arkansas Rice Growers Cooperative Organization continued to be a major rice cooperative in Arkansas. In June 1930, it owned three mills: two of them were operating and one was used for storing rice (R.J. 33 [6], p. 16). In 1940, the association owned two rice mills, one at Stuttgart, purchased in 1928, and the other at Jonesboro, purchased in 1939. In 1946, it introduced its own branded consumer rice. By 1950, the association owned and operated three large mills and maintained a large number of warehouses and bulk-rice storage facilities (Efferson 1952, p. 514).

Arkansas Grain Corporation, a marketing cooperative, was organized at Stuttgart in 1958 as an affiliate of the Arkansas Rice Growers Cooperative Association and its subsidiary Grain Drying Cooperatives. The corporation was designed to do for soybeans and other grains what the Rice Growers Cooperative Association did for rice. Local cooperatives were also affiliated with the Arkansas Rice Growers Association. J. Jenneth Samuels (1968, p. 16) reported in 1968:

> By 1967 all the eighteen local drying and storing cooperatives were affiliated with Arkansas Rice Growers Association.... Business affairs of the association are conducted by a board of directors elected by members and including one director from each of the eighteen affiliated driers.

In September 1970, the name Riceland Foods was selected for the corporate complex made up of the Arkansas Rice

Growers Cooperative Association, the Arkansas Grain Corporation, and the eighteen affiliated grain drying cooperatives in eastern Arkansas. Since 1970, the central office of the Riceland Foods has been located in Stuttgart.

Riceland Foods, Inc. is the largest miller of rice in the United States, and the nation's fifth largest grain storage company. It now provides marketing services for rice, soybeans, wheat, milo, corn, and oats grown by the members in Arkansas and nearby states (Riceland Foods, Inc. 1986, Annual Report).

B-2) Producers Rice Mill

In 1943, Producers Rice Mill was organized. In 1946, the cooperative expanded with the organization of Producers Dryer, Inc. As of January 1983, the cooperative served 1,600 members. It maintains two mills, both located in Stuttgart, but one operated only for parboil purposes (R.J. January 1983, p. 12). Producers Rice Mill and Riceland Foods are two of the most important rice cooperatives in the Lower Mississippi River Valley, even though the former is far smaller in its operational scale than the latter.

B-3) Louisiana Rice Growers Association

The Louisiana Rice Growers Association was organized at Welsh in November 1908 by Louisiana rice farmers and representatives of the Texas Rice Farmers Association. W.

B. Gabbert, a prominent rice farmer, became the head of the association. About sixty farmers from Welsh and the surrounding vicinity joined the association at its first meeting. At subsequent meetings they were joined by farmers from Welsh, Jennings, Crowley, and Egan. The plan was to organize local branches in every rice-growing community in Louisiana under a state organization, which would promote cooperation among the rice growers for the common interests in the collection of data, the marketing of crops, and the exchange of information (R.J. 12 [2], p. 26).

B-4) Texas-Louisiana Rice Farmers Association

In February 1909, the two state organizations [of the Louisiana Rice Growers Association and the Texas Rice Growers Association] merged into the Texas-Louisiana Rice Farmers Association. Hezekiah Winn of Lake Arthur, Louisiana, became the first president of the association (Daniel 1985, p. 52).

B-5) Southern Rice Growers Association

In December 1910, the Southern Rice Growers Association, an interstate rice cooperative, was organized by the rice growers in the three rice-producing states of Louisiana, Texas, and Arkansas with its headquarters located at Beaumont, Texas. At one time the association's membership represented about three-fourths of all the rice growers in the southern states. The marketing cooperative operated with considerable success until 1920 (Daniel 1985, p. 53; Efferson 1952, p. 512).

B-6) American Rice Growers Cooperative Association

The decline of the Southern Rice Growers Association was followed by the organization of the American Rice Growers Association in 1921. The new association was operated in much the same way as the marketing cooperative of the Southern Rice Growers Association. In 1928, the American Rice Growers Association was reorganized and renamed into the American Rice Growers Cooperative Association. The association has operated as a federated group of local cooperatives since the articles of incorporation were changed to permit the association to operate as a federate type in 1931. By 1950, the association handled an estimated 50 percent of the total rice crop of the Louisiana-Texas area. By 1967, the association handled 70 percent of the Texas rice crop and about a fourth of the Louisiana rice crop (<u>R.F.</u> September 1967, p. 18).

In an organizational sense, the actual members of the association are local cooperative rice driers. Individual farmers are members of these local units, with the central office located at Lake Charles, Louisiana. Through the local cooperatives, the association advises the farmer whether to sell or hold, although the actual decision is up to the farmer. The association is affiliated with the American Grain Association, which was organized in 1965 for marketing soybeans (Efferson 1952, pp. 512-514; Berberich and others 1970, pp. 210-211).

B-7) American Rice, Inc.

American Rice, Inc. was organized on March 19, 1969, by six Texas rice farmers representing six rice-producing areas: C. A. Kiker, Beaumont; R. C. Gatlin, Raywood; F. M. Graves, Dayton; A. M. Robichaux, Katy-Brookshire; Max Rotholz, El Campo; and Jay Anderson, Eagle Lake. During the first year of operation it provided a state-wide grading service, and from the second year it began developing an improved marketing system. In 1971, it marketed rice worth of $25 million; in the next year, this figure rose to over $41 million; by January 1974, it was associated with more than 700 rice farming operations encompassing 200,000 acres in Texas and in Louisiana (R.F. January 1974, p. 22). In January 1983, the cooperative served 1,600 members of Texas and Louisiana farmers and sold about 10 percent of its rice to the domestic market under the cooperative's brand names. The other 90 percent was marketed in the international market, which amounted to about 15 percent of all the U.S. rice sold overseas (R.J. January 1983, p. 8).

C) Rice Promotion Organizations

C-1) Rice Association of America

The southern rice industry was threatened with successive droughts during the years 1894 and 1895. Moreover, as the Wilson-Gorman Act lowered the tariff on head rice in 1894, southern rice farmers had to compete with the imported rice from Asia. Because of the droughts and the lowered tariff, rice production was remarkably reduced in Louisiana during the years 1894 and 1895. In order to overcome the emergency in the southern rice industry, Seaman A. Knapp organized the Rice Association of America during the winter of 1894-1895 (Bailey 1945, p. 127).

The headquarters of the association was located at Crowley, Louisiana. "The objectives of this organization were to find and develop markets for rice and rice products, to compile and distribute information relative to the rice industry, and to expand consumption by using all available means and methods of advertizing the value of rice as a food" (Efferson 1952, p. 512). In 1897, Knapp helped draft a petition to Congress, arguing that "the new industry needed time to make the adjustment to machine methods of production" and that it was "obliged to compete with the lower paid labor" in the Asian rice-producing countries (Bailey 1945, pp. 127-128). The activities of the association were effective in promoting domestic rice consumption and in restoring a high tariff wall on head rice. However, the association became inactive after several years' activities (Efferson 1952, p. 512).

C-2) Other Rice Promotional Organizations before 1950

There were a number of rice promotion organizations in the South even before state promotion organizations were formed in the early 1950s. Some local promotion organizations published rice recipe books as early as the 1930s (R.J. April 1980, p. 6). The Rice Industry [later the Rice Council], a nationwide promotion organization, appeared in the late 1950s.

C-3) Texas Rice Promotion Association

The Texas Rice Promotion Association was founded by a group of Texas rice farmers in 1950, and the first membership meeting was held at Awin, Texas, on March 2, 1951. The first meeting was attended by about four hundred participants including the rice farmers and the representatives of rice driers and irrigation companies (R.J. 54 [4], p. 9). By June 1955, the membership of the association embraced about seventy-five Texas rice farmers. Each of the members was obliged to contribute five cents per barrel [162 pounds] of rough rice that they sold (R.J. 58 [6], p. 42). The association became a subgroup of the industry-wide Rice Council for Market Development after the Rice Council was organized in 1959.

C-4) Arkansas Rice Promotion Association

On March 12, 1951, about fifty Arkansas farmers and representatives of the Arkansas rice industry met together at Stuttgart to discuss the promotion of domestic rice consumption. One month later, the Arkansas Rice Promotion Association was officially organized at the Riceland Hotel, Stuttgart, Arkansas (R.J. 54 [6], p. 6). After a year and a half, the association was supported by over 3,000 members representing thirty rice-growing counties in Arkansas (R.J. 55 [12], p. 10). When a rice grower became a member of the association, he agreed to contribute one-half cent per bushel [45 pounds] of rough rice that he sold.

C-5) Rice Industry: Rice Council for Market Development

The Rice Industry originated at a meeting held in Memphis, Tennessee, in September 1957, and from the following month it started collecting funds for milling and production. Regular dues were collected from member mills and member producers. Claude R. Miller became the first president of the Rice Industry, and on April 1, 1958, Claybourne B. Ross was appointed general manager by the directors. In an address delivered to the annual convention of the Rice Millers Association on May 23, 1958, Claude R.

Miller, president of the Rice Industry, mentioned the objectives of the organization (R.J. June 1958, p. 10):

> Our first objective is the sales effort which can be subdivided into the public relations program and the advertizing. Second is market research, which is divided into assigned product research and test kitchen work. Third is administration, which is divided between the central office and field service.

The Rice Industry changed its name to the Rice Council for Market Development in 1959, but remained a rice promotional organization on a nation-wide basis. The Rice Council, the headquarters of which is located in Houston, is a nonprofit, nonpolitical organization. It is supported by rice farmers, millers, and all segments of the rice industry in Arkansas, Louisiana, Mississippi, and Texas. It is connected with many business firms that deal with the rice industry; the business firms are associate members of the council. But it does not conduct activities of political or legislative-influencing nature. It conducts two programs: a domestic market promotional program and a foreign market development program. The domestic program includes development of new recipes, youth and adult programs, March rice week and October harvest festival promotions, and serving the nation's press, radio, and TV (R.J. July 1964, p. 5; R.F. June 1978, p. 28).

D) Rice Experiment Stations

One of the primary research projects at the rice branch experiment stations has been to find or breed more suitable and productive rice varieties. In fact, the experiment stations have developed and improved a great number of new varieties, often in cooperation with the seed rice growers, and distributed them for commercial growing (see Chapter V). The research projects at the experiment stations have also included many aspects of rice culture: rice cultivation, rice harvesting, rice drying, rice processing, efficient method of fertilization, soil and water management, and crop combination and crop rotation. The research results at the stations have been reported in periodic journals or their own circulars.

In addition to the research programs, field days are held once or twice each year. The field days are attended by rice growers and others interested in rice farming, and the attendants have a chance to observe research work under field conditions and to discuss production problems.

The state experiment stations benefit more than just the farmers within each state. The stations exchange information and research results with each other, and research reports or publications are available anywhere in the world by request from the central office.

D-1) Rice Experiment Station at Crowley, Louisiana

A number of southwestern Louisiana rice growers met together at Crowley on December 12, 1901. At the meeting, it was resolved that a rice experiment farm would be established on the prairies of southwestern Louisiana and provisions were made for petitioning the legislature. The existing agricultural stations in Louisiana, located at that time at New Orleans, Calhoun, and Baton Rouge, were not favorably located for the experiments on prairie rice growing[1] (R.J. 5 [2], p. 5).

After several years had passed since the rice growers of southwestern Louisiana had adopted the above-mentioned resolution, a committee was appointed to investigate and deliberate the question of the rice experiment station location at a meeting of the State Board of Agriculture held in Baton Rouge on September 15, 1908. The U.S. Department of Agriculture promised to cooperate with the state committee, and the rice growers were also in support of the plan (R.J. 12 [5], p. 98).

The committee chose the site on the west edge of Crowley from among several alternatives, because the soil at the site was, they believed, a typical type of prairie soil

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1 The three stations were established when the rice growing of the state was largely confined to southern Louisiana along the Lower Mississippi River. The experiment station at New Orleans was to study the interests of the sugar industry; the one at Baton Rouge, located on bluffland, was to study the interests of the cotton planters; and the one at Calhoun, located on the pine hills, was devoted to the interests of the small farmers of the hill lands (R.J. 5 [2], p. 5).

in southwestern Louisiana. The selected site was easily reached by a public road from downtown Crowley and it was relatively near to Baton Rouge (R.J. 12 [5], p. 98; R.J. 35 [4], p. 9). The Rice Journal (35 [4], p. 9) reported:

> A group of public spirited citizens of Crowley and of Acadia Parish contributed funds, purchased a sixty acre tract of land one mile west of Crowley, and made a gift of land to the Acadia Police Jury (parish commissioners) upon condition that the property be perpetually used for practical experiments on rice culture. The Police Jury in turn assigned the property to the Agricultural Experiment Station of the Louisiana State University at Baton Rouge upon the same conditions named in the donation to the jury.

In 1930, Louisiana State University purchased an additional 51 acres of land adjoining the original tract. Thereby, the total holdings of the Rice Experiment Station increased to 111 acres (R.J. 35 [4], p. 9). But, as time passed, the site and the facilities of the station came to be inadequate. In 1949, 719 acres of land, at the present site of the Rice Experiment Station in northeast Crowley, were purchased, and a total of 830 acres were available for research at the station (R.J. Annual 1955, pp. 46-47).

In 1950, field experiments were first conducted on the newly purchased tracts. As a brick administration building was completed early in 1951, the Rice Experiment Station was relocated to the present site, two and a half miles northeast of Crowley on Interstate 10 (old U.S. Highway 90). The Rice Experiment Station consisted of 771 acres until 1963, when 324 additional acres of land not adjacent to the main tracts of the station but located one mile south of

Crowley on State Highway 13 were purchased. In the next year, the old station's 51 acres, which had been used as tracts for beef cattle research, were returned to the Acadia Parish Police Jury; the size of the station became 1,040 acres of land.

The station has conducted various experiments on soybean production in conjunction with rice farming since it began to emphasize soybean research in 1963. Crawfish raising is one of the current subjects of research conducted at the station.

D-2) Rice Experiment Station at Beaumont, Texas

The Rice-Pasture Experiment Station was established in 1909 on 100 acres of land on the outskirts of Beaumont. In 1912, the station obtained the cooperation of the U.S. Department of Agriculture, which not only supplemented available research funds but also provided excellent sources of rice seed of various varieties from all over the world. That year, 122 varieties of rice were tested at the station. In 1931, the USDA began a cooperative and comprehensive rice-breeding program with the station (Texas Rice Research Foundation 1987, Annual Report). In 1945, the station moved to its present 930-acre complex on Imes Road, just west of Beaumont on U.S. Highway 90. In 1960, the station purchased an additional 290 acres of land. At that time the size of the station was increased to about 900 acres. The station added soybean research but stopped cattle-raising research during the mid-1970s. Therefore, it is no longer called Rice-Pasture Experiment Station; the official name of the station is Texas A&M University Agricultural Research and Extension Center at Beaumont.

The research of the station has been conducted in a cooperative agreement with the Texas Agricultural Experiment Station, the U.S. Department of Agriculture, and the Texas Rice Improvement Association.[2] The Texas Rice Research Foundation has also supported the station's research since the early 1980s. Many farm organizations, commercial business firms, and individual farmers have also contributed material, service, and land to research conducted by the station.

In 1972, five research sites west and south of Houston were added at Eagle Lake, Bay City, El Campo, Ganado, and Katy by the Texas A&M University Agricultural Experiment Station. The Rice Experiment Station at Eagle Lake was located there because of the increased rice production in the western portion of the Texas rice belt and because of the distance of this area from the Beaumont station. The soil type near the Eagle Lake station, situated farther inland, is sandy loam with no hardpan, which is considerably

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2 The Texas Rice Improvement Association is a nonprofit organization of rice farmers, ranchers, and others interested in improving agriculture on the Gulf Coast of Texas.

different from the prevailing soil type found along the Gulf Coast Prairies. The Eagle Lake station, as a satellite of the Beaumont Rice Experiment Station, cooperates with the Beaumont station in many research projects.

D-3) Rice Experiment Station at Stuttgart, Arkansas

The Rice Branch Experiment Station at Stuttgart was established by the University of Arkansas Agricultural Experiment Station in 1927. Arkansas has been indebted to the Stuttgart station for the tremendous increases in rice production in Arkansas during the recent decades. The research programs of the station include not only all aspects of rice production in Arkansas, but also other types of agricultural activities that may be complementary to rice farming. Along with the University of Arkansas Experiment Station staff members, the USDA, Interior Department, and the Corps of Engineers have been involved in cooperative research efforts at the station. Recently, the University of Arkansas Main Experiment Station at Fayetteville, the Southeast Branch Station at Rohwer, and the Northeast Branch Station at Keiser have become more active in rice research programs. The Rice Experiment Station at Stuttgart includes an administrative building, residence for some of the station personnel, laboratories, greenhouses, a pilot rice mill, grain storage facilities, and machinery buildings (Figure VII-1).

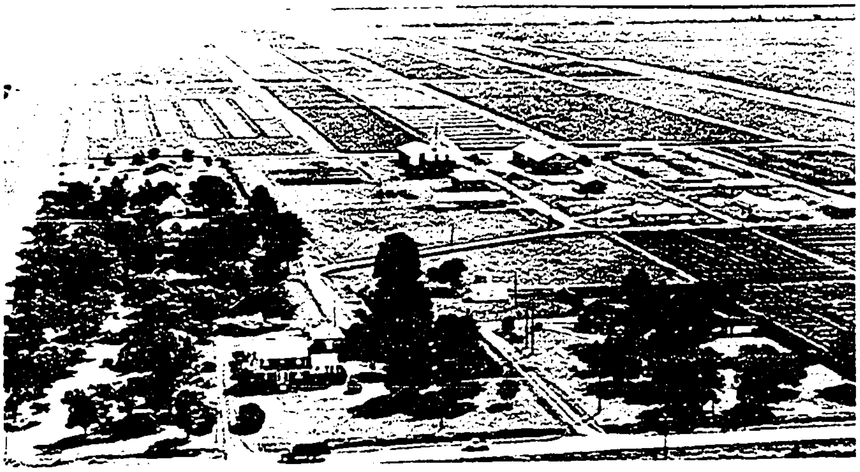

Figure VII-1. Rice Branch Experiment Station at Stuttgart, Arkansas (Courtesy of the Stuttgart Station).

D-4) Delta Branch Experiment Station at Stoneville, Mississippi

Commercial, large-scale rice production in Mississippi began in 1948, and the Stoneville station began to do research on rice farming in 1958. Sixteen rice varieties were tested at the station in 1966, and four long-grain varieties of Bluebelle, Dawn, Starbonnet, and Bluebonnet 50 were selected as recommendable varieties for the Mississippi rice growers.

In that cotton is the most important crop in the Yazoo Basin, the research on the cotton crop is treated as the most important part of the activities at the station. The soybean crop is the second important crop, followed by the rice crop. The natural environment of the Yazoo Basin is similar to that of the Arkansas floodplains. But in the Yazoo Basin, rice is planted on more clayey soil than in Arkansas. Relatively short-stalk rice varieties are required on the clayey buckshot soil in order to harvest rice without lodging.

E) Other Organizations Concerned with Rice and the Rice Industry

E-1) U.S. Rice Producers, a Division of the American Farm Bureau

The U.S. Rice Producers, a nationwide organization of rice farmers, was organized in March 1972. The purpose of the organization is to exchange information about problems to be solved among the U.S. rice farmers, and to make a united effort for legislation through the American Farm Bureau Federation. In this manner, the U.S. rice farmers have a better chance of solving many of the industry's problems (R.J. April 1975, p. 20; R.F. May 1972, p. 20).

E-2) Rice Research and Marketing Advisory Committee

The Rice Research and Marketing Advisory Committee was established under the Research and Marketing Act of 1946. Each year the committee (composed of nine representatives from the rice industry) recommends vital issues of the rice industry to the U.S. Department of Agriculture. The vital issues include a wide range of research programs on rice production, processing, and marketing. The Agricultural Research Service of the USDA thereby learns the wishes of people in the rice industry, and can be guided in its studies (R.J. Annual 1955, p. 70).

E-3) Arkansas Rice Research and Promotion Board

The Arkansas Rice Research and Promotion Board was created in 1985 so as to promote growth of the Arkansas rice industry. The board administers a program of research, extension, promotion, and market development. The board consists of nine Arkansas rice producers appointed by the governor. Programs are funded by an assessment of three cents per bushel [45 pounds] of rough rice, collected at the first point of sale, on all rice produced in the state (Arkansas Rice Research and Promotion Board 1988, a leaflet "Celebrate Rice").

E-4) National Rice Research Board

The National Rice Research Board was established in 1987 as a cooperative effort of all rice-producing states. The purpose of the board is to solicit funds from agricultural industries which generate revenue from the sale of input items for rice production. Money collected will be used to fund specific research proposals developed by the state experiment stations (Arkansas Rice Research and Promotion Board 1988, a leaflet "Celebrate Rice").

CHAPTER VIII

POLICIES AND PROGRAMS

During the period from the outbreak of the Civil War until the end of the First World War, the United States never produced enough rice to supply the domestic demand, having to make up the shortage by imported rice from abroad, mostly from Asian countries. Both rice production and acreage increased rapidly in the United States during the first two decades of this century. Encouraged by an increased rice demand in the international market, production increaed dramatically, changing the United States from a net importing country to a net exporting country after the First World War.

The first political concern for rice producers occurred with the question of tariff duties on imported rice. Southern rice growers and millers struggled with those who favored low tariff duties on rice, or those who opposed the tariffs on rice completely. The opponents were (1) the rice millers of San Francisco and New York, (2) the champions of the consumer, (3) the brewers, and (4) the importers of foreign rice (Daniel 1985, pp. 56-57; Phillips 1952, p. 91). In the 1920s, when the U.S. became a rice exporter, the rice growers and the rice millers in the South were still concerned with low tariff duties on imported rice. Daniel (1985, p. 57) explained:

> In the 1920s, rice politicians managed to preserve tariff duties on imported rice. Despite their small political base, rice farmers managed to protect their industry from imports; in that sense they were quite different from most southern farmers, who traditionally opposed a high tariff.

During the years from 1919 to 1932, domestic rice production was relatively stable (Figure II-10; Appendix III), but, as the international demand dwindled, the domestic rice carry-over grew gradually. The season average price for rough rice declined steadily from 5.46 dollars/cwt in 1919 to 0.93 dollars/cwt in 1932 (Figure VIII-1; Appendix IX). As a result of price decline, rice growers were thrown away in a difficult situation; hence the necessity of agricultural legislation for the rice industry.

The idea of agricultural legislation to solve farm problems was represented by the McNary Haugen plans in the years from 1924 to 1928. The plans never gained popularity in those days, however; they were vetoed by the president twice. Finally, the Agricultural Marketing Act of 1929 brought about the Federal Farm Board, which was to assist marketing cooperatives that would buy surplus crops to keep them off the market. But the Federal Farm Board also failed from the beginning, because of the Depression and the large surpluses of agricultural crops. Both the ideas of the McNary Haugen plans and the rationale of the Federal Farm Board reappeared in the Roosevelt period (Benedict 1975, pp.

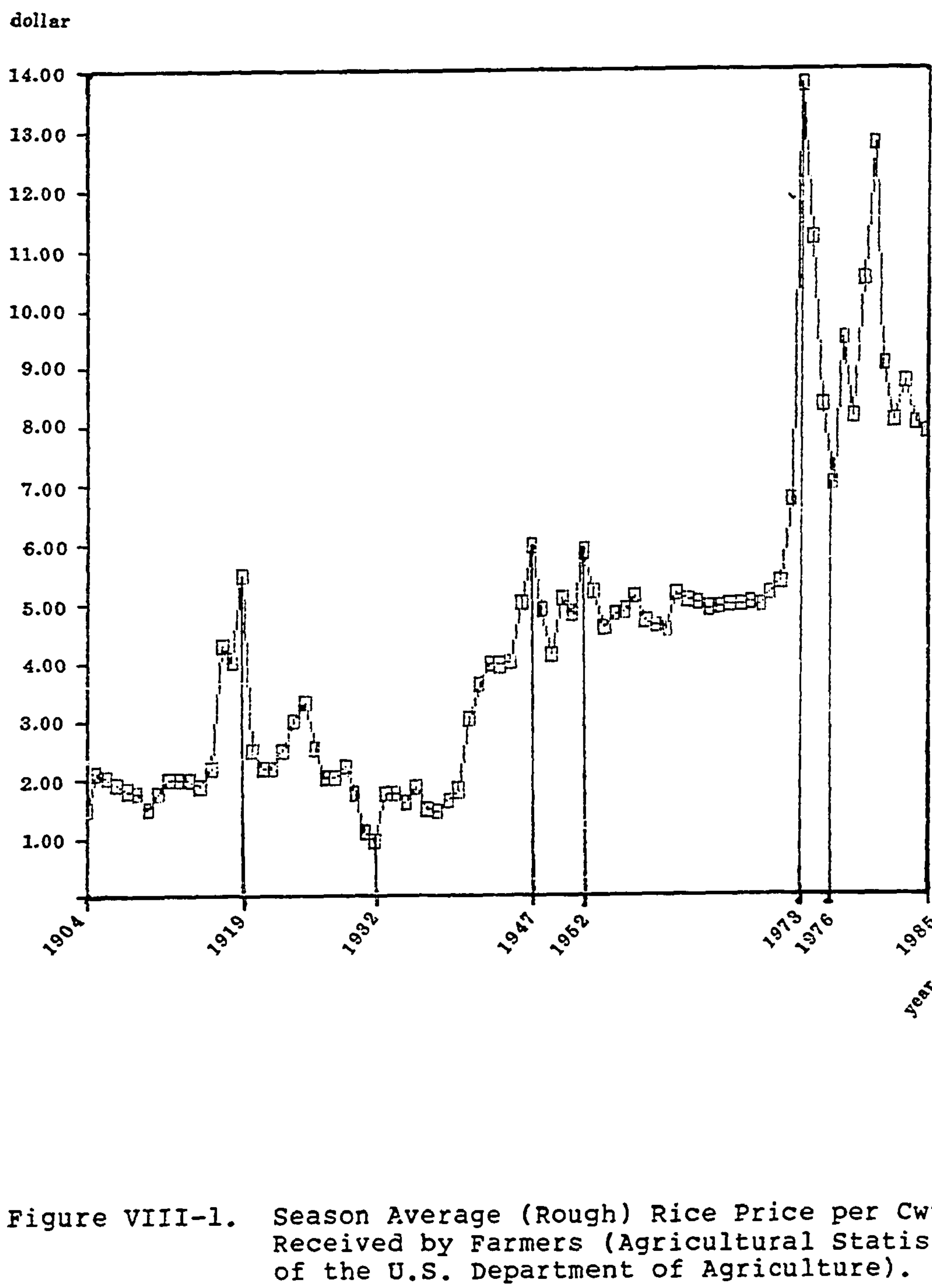

Figure VIII-1. Season Average (Rough) Rice Price per Cwt Received by Farmers (Agricultural Statistics of the U.S. Department of Agriculture).

211-241; USDA 1984, p. 23).

A) The Agricultural Adjustment Act of 1933

The first Agricultural Adjustment Act, of May 12, 1933, granted to the Secretary of Agriculture a wide range of powers to solve the farm problems. The emphasis of the legislation was on programs for reduction in acreage or production of any basic agricultural commodity and on measures for acceleration of income flow into agriculture. Rice was included in the basic crops in the AAA of 1933, as it has been in subsequent acts (Efferson 1952, p. 428; Benedict & Stine 1956, p. 138; Benedict 1975, p. 282).

A-1) Rice Programs for the 1933 and 1934 Crops: The Acreage Control Program and Marketing Agreements

Throughout the summer and fall of 1933, rice growers, rice millers, and the Rice Section of the AAA debated a plan to increase prices, to reduce acreage, and to provide orderly marketing. The Rice Section finally announced a parity price and a resale price for rice, and rice millers agreed to the Rice Section's decision. But because of confusion and poor administration, the marketing agreement could not be enforced in an orderly manner in that year (Daniel 1985, pp. 136-137).

During the winter of 1933-1934, details of an acreage control program and a marketing agreement were established for the rice industry of the South and California. According to the 1934 acreage control program, "Arkansas and Louisiana rice growers should cut production by 20 percent, using the past five years' average, and Texas rice growers should cut by 22 percent, using the past three years as the base period "(Daniel 1985, p.137). Most of the southern rice farmers agreed with the Secretary of Agriculture in their acceptance of a production quota for the 1934 rice crop (R.J. 37 [7], p. 8). According to the 1934 marketing agreement, signatory millers were supposed to pay 60 percent of the parity price to the rice growers at the time of purchase and to pay the remaining 40 percent to a AAA trust fund held for distribution by the Secretary. The trust fund "would be disposed to cooperating producers, while farmers who refused to cooperate would not receive the additional 40 percent" (Daniel 1985, p. 138). Most of the southern rice millers agreed with the Secretary of Agriculture on the marketing agreements (R.J. 37 [12], pp. 7-8).

Whereas farm-based acreage allotments were in effect for other commodities, producer-based acreage allotments were established for the rice crop. This program was thought to be appropriate for the rice crop because tenants as well as landowners had already invested a lot of capital into mechanization; many tenants had expensive binders, tractors, and irrigation facilities. Moreover, crop rotation was widely practiced by rice growers, and they often rented rice land from others while their land was planted with other crops (Daniel 1985, pp. 137-138).

The acreage control program and marketing agreements for the rice crop of the year 1934 encountered numerous protests and objections from both rice growers and rice millers (R.J. 37 [2], pp. 8-9; Daniel 1985, p. 139). Confusion and mismanagement carried over to marketing season. Producers who had sold to cooperating mills did not receive the supplemental 40 percent within the promised thirty days, while those who sold to non-cooperating mills could receive the full market price. By December 1934, the programs had to be abandoned (Daniel 1985, p. 140; Efferson 1952, p. 428).

A-2) Rice Programs for the 1935 Crop: The Processing Tax and Benefit Payment System

After the marketing agreement was totally abandoned, the Rice Section of the AAA adopted a processing tax and benefit payment system. A substantial amount of money was supposed to put in the hands of rice growers through the benefit payments which were to be drawn mainly through processing taxes on the rice commodity. A processing tax of one cent per pound, assessed and collected upon the first domestic processing of rice, was put into effect in April 1935 (Benedict & Stine 1956, p. 140). Rice acreage and production were kept down at a relatively stable level throughout 1935. Still, some rice millers and some rice farmers objected to the processing taxes. In January 1936, the Supreme Court declared all processing tax and acreage reduction contracts as unconstitutional in U.S. vs. Butler, commonly known as the Hoosac Mills case (Daniel 1985, pp. 145-147; Efferson 1952, p. 428; Benedict 1975, pp. 302-303 and p. 348).

B) The Soil Conservation and Domestic Allotment Act of 1936

As the Hoosac Mills decision eliminated the processing tax and acreage contracts with growers, the federal government prepared new legislation. A farm act named as the Soil Conservation and Domestic Allotment was signed by President Roosevelt on February 29, 1936 (R.J. 39 [3], p. 1). Funds for the execution of the 1936 act were now to be appropriated by the Congress from the Treasury, instead of through processing taxes (Benedict 1975, p. 350).

B-1) Rice Programs for the 1936 and 1937 Crops

The Rice Section of the USDA set up a new program under the Soil Conservation and Domestic Allotment Act. The new program of the Rice Section operated much like the acreage control program and marketing agreements of the 1933 AAA. A grower was to plant between 85 to 100 percent of his allotment and it was stipulated that he must plant acreage at least equal to a fourth of his rice allotment with "soil-conserving crops"[1] (Daniel 1985, pp. 147-149). The soil-conserving crops were those which protect and rebuild soils and which, for the most part, did not contribute directly to the burdensome surpluses of commercially handled farm products (Benedict 1975, pp. 350-351). For the years of 1936 and 1937, a rice grower received payments for participation in the new program, and he was penalized if he over-planted his allotment or did not plant soil-conserving crops (Efferson 1935, pp. 428-429; Daniel 1985, p. 148). Despite these efforts to reduce acreage, the new program under the 1936 act did not gain any noticeable success. Rice farmers extended rice acreage and rice production grew considerably during the years the program was in effect.

C) The Agricultural Adjustment Act of 1938

More comprehensive legislation was set up in order to compensate for the weakness of the Soil Conservation and Domestic Allotment, and finally the Agricultural Adjustment Act of 1938 was approved on February 16, 1938. The AAA of 1938 provided the rice industry with legal basis for the many new programs including the following: (1) definite acreage allotments for rice; (2) marketing quota controls

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1 Crops were classified into two categories, soil-depleting crops and soil-conserving crops. The latter included the grasses, legumes, and other forage crops; the former were, in general, cash crops such as wheat, cotton, tobacco, and sugar beets.

operating through rice acreage allotments, if approved by more than two-thirds of rice producers; (3) authorization for nonrecourse storage loans[2] to maintain price; and (4) direct payments to bring producers prices up to parity prices (Efferson 1952, p. 429; Daniel 1985, pp. 148-149; and R.J. 41 [2], p. 22).

C-1) Rice Programs for the 1938, 1939, and 1940 Crops: The Acreage Allotment System

Under acreage allotments, producers were eligible for the AAA benefits such as price support and soil conservation payments only if they complied with the rice acreage allotment. Each year the Secretary of Agriculture was to declare a national rice acreage allotment, which would be "the number of acres, at average yields, necessary to adjust the total supply of rice in the U.S. to a normal supply for the following marketing year" (R.J. 41 [2], p. 22). Producers were assigned acreage based on previously established allotments. Referendums on the marketing quotas[3] were held on the 1939 and 1940 rice crops, but rice

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2 Under the nonrecourse storage system, if the price falls below a specified support level, the borrower (producer) can choose to surrender the product in satisfaction to the loan without any responsibility for any loss that might thereby accrue to the government.

3 If marketing quotas were to be proclaimed by the Secretary of Agriculture, a referendum must be held and more than two thirds of the votes must support marketing quotas.

growers voted down the marketing quotas both times (Efferson 1952, p. 429).

C-2) Rice Programs for the 1941-1954 Crops

During the Second World War and the unstable postwar period, the annual productions and exports of the U.S. grew remarkably. The U.S. rice export grew at a rapid rate not only because of the unusual demand for rice in the international market but also because of the U.S.'s efforts to maintain adequate food supply in allied countries (Efferson 1952, p. 431). The total U.S. rice production also increased from 23.1 million cwt in 1941 to 64.2 million cwt in 1954; the South was responsible for 19.3 million cwt in 1941 and 52.0 million cwt in 1954 (Figure II-10; Appendix III).

Because of the strong demands and high prices, rice acreage allotments were lifted entirely for the 1941-1949 crops. Difficulties in marketing the overproduced U.S. rice began to arise in 1948, and the problems of overproduction became serious. In December 1949, the U.S. Department of Agriculture instituted rice acreage allotment and the Secretary of Agriculture announced downward adjustments for the 1950 rice crop. The national acreage allotment for 1950 was 1,593,112 acres, 13.7 percent below the 1,845,000 acres planted in 1949 (Daniel 1985, p. 275; R.J. 53 [2], p. 8). In 1950, rice growers, after protests over the allotment, planted more than allotted acreage, but still 237,000 acres[4] fewer than the year before (Daniel 1985, p. 277). The U.S. Department of Agriculture did not enforce the acreage allotment in 1951, 1952, 1953, and 1954. Although rice production far exceeded the demand in the U.S. in these years, the problem of overproduction was eased in 1951 and 1952 by the disruption of rice production and distribution in the Far East resulting from the Korean War (from June 1950 to August 1953) and the Chinese Civil War (Reid & Gains 1952, p. 8; Daniel 1985, p. 277).

C-3) Rice Programs for the 1955-1973 Crops

In 1955, beginning mill stocks amounted to as much as 11.9 million cwt. Therefore, the U.S. Department of Agriculture decided to resume acreage allotment for the 1955 crop. The marketing quotas for the 1955 crop were approved by rice producers in a referendum held on January 28, 1955, and the marketing quota system was therefore put into effect. The federal government imposed stiff fines on the producers who overplanted their allotted acreage. A farm-based acreage allotment system was applied to Arkansas, Mississippi, and Louisiana[5] farmers; a producer-based

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4 The 1949 rice acreage was 1,857,000 acres and the 1950 rice acreage, 1,620,000 acres (Agricultural Statistics of the U.S. Dept. of Agriculture).

5 The river rice district of Louisiana had producer-based acreage allotment system from 1958. However, the southwestern Louisiana farmers went on with farm-based

acreage allotment system was, however, applied to Texas and California farmers. The reduced or farm-based allotment system drove many tenant farmers and small farmers from rice production. From 1955 through 1973, the U.S. Department of Agriculture annually issued acreage allotments and marketing quotas, and so controlled rice acreage (R.J. 54 [2], p. 5 and p. 16; Daniel 1985, pp. 279-287; Godwin, Jones, and others 1970, pp. 77-78, 92-95).

C-4) Rice Programs after 1974

The season average price for the 1973 rice crop was raised sharply due to the increased demand for rice in the international market (Figure VIII-1; Appendix IX). The price that year more than doubled the average price of the previous several years, and prices remained relatively high in the following several years. Rice marketing quotas were suspended[6] for the 1974 crop and also for the following years' crop. The focus of rice policies gradually was changed from the control of production to the expansion of rice markets. In 1981, the rice acreage allotment and marketing quota system was completely abandoned. Instead of these programs, the acreage reduction program was employed (USDA 1984, pp. 25-26). The 1981 rice production again

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acreage allotment system.

6 The suspension allowed a grower to plant any amount of rice without penalties if he was willing to do without the loan program.

expanded dramatically, increasing over 25 percent within the year. The 1981 rice crop was more than double the 1971 crop (Appendix III). Increasingly based on price and income support systems, the rice policies have become more complex (Appendix X).

D) Price and Income Support Operation

The U.S. government has supported rice producers with various price and income support programs since 1948, when the Commodity Credit Corporations became effective for the rice crop.

D-1) The Commodity Credit Corporations from 1948

The price support programs through the Commodity Credit Corporations were first organized in 1933, but it was through the revised CCC act of 1948 that rice farmers could put their rice under CCC loans for the first time. The amount of rough rice owned by the CCC was 0.5 million cwt by July 31, 1949, and it grew to as much as 11.4 million cwt by July 31, 1955. Rice growers had to observe government rice programs in order to be eligible for CCC supports. Growers could store their rice in approved farms or commercial facilities, and then obtain the CCC loans on the stored rice. The CCC loans were repaid as follows (Godwin, Jones, and others 1970, p. 81):

> The maturity date for rice loans is April 30. Loans can be redeemed at any time prior to maturity by repayment of the principal amount plus charges (mainly 30 cents per $100.00 per month. If loans are not repaid, the rice pledged as security is taken over by the government at maturity, and a service charge of one cent per one hundredweight is made on each hundredweight delivered.

The CCC support was especially significant in the years from 1954 to 1957 and from 1982 to 1985, when more than 40 percent of U.S. rice production was put under the CCC support. The amount of rice acquired by the CCC through loan forfeitures was more than 10 million cwt in the crop years of 1954, 1955, 1956, 1975, 1981, 1983, 1984, and 1985. Rice acquired and accumulated by the CCC has been used mainly for export.

The CCC has functioned as a medium through which the U.S. rice price has been supported and maintained. The support prices of the CCC have protected rice farmers from the fluctuations of rice price, by providing the farmers with basic income floors (Tyner 1970, p. 178; R.J. May 1972, p. 14).

D-2) The Deficiency Payment System and the Disaster Payment System

A target price system was enacted in 1976. Deficiency (direct) payments were to be made on the difference between the August-December average farm price and the target price, but the eligibility for the deficiency payment was restricted to rice from alloted acres (USDA 1984, p. 26).

Also a disaster payment system has been employed since 1975 in order to cover losses due to natural causes that either prevented the crop from being planted or resulted in abnormally low yields.

D-3) Export Subsidy Payment

The U.S. rice has moved into the international market at adequate prices through the export subsidy payments equal to the difference between the world price level and the U.S. domestic price (Godwin, Jones, and others 1970, p. 76). As a substantial amount of rice has been exported through the export subsidy payment, the rice supply in the domestic market has been reduced and the domestic rice prices have been better maintained.

D-4) Public Law 480

In 1954, the Public Law 480 (the Agricultural Trade and Development Assistance Act) was approved. This legislation has authorized the export of surplus commodities (including rice) to friendly countries under various titles: donations, long-term credit sales, or barter for strategic materials (Daniel 1985, p. 285; Appendix XI). During the last ten years 1976 to 1985, the total U.S. rice export under the PL-480 amounts to 105.8 million cwt of (milled) rice, of which about 81 percent was exported through the long-term credit sales [Title I] with the remaining 19 percent donated to foreign countries [Title II] (Appendix XI).

CHAPTER IX

SUMMARY AND CONCLUSION

The preceding chapters have traced the development of southern rice culture from the viewpoint of historical geography. Although rice could possibly be grown as far north as the Great Lakes in the United States, it has been produced mainly in limited areas of the South because of their relative advantages in rice production. The South Atlantic Hearth was the dominant producer during the colonial and antebellum periods, based primarily upon the tidal flooding of fields located on floodplains of a number of streams. After the outbreak of the Civil War rice production of the region declined, but the region kept the leading position until the 1880s. Southern Louisiana produced remarkable quantities of rice along the Lower Mississippi River from the antebellum period, reaching a peak of rice production in the 1890s. In addition to these two areas rice culture on a large-scale, commericial basis also emerged in the prairies of southwestern Louisiana in the 1880s, from which it spread throughout the Gulf Coast Prairies of southwestern Louisiana and southeastern Texas. Large-scale, mechanized rice culture also developed in the Lower Mississippi River Valley during the first decade of this century; the Grand Prairie was the cultural hearth of this region. The Gulf Coast Prairies and the Lower Mississippi River Valley remain the most important two rice-producing regions in the American South.

This dramatic shift from the South Atlantic Coast to the present areas of production was brought about by a number of factors. The physical environment, including water resources, soil type, and growing season, certainly were important, but the spatial aspects of southern rice culture have been much more due to the human factors, which may be grouped into five categories; technological processes, agronomic processes, social processes, political processes, and economic processes.

The technological development of water supply and management has been especially significant to rice cultivation. Rice growers in the South Atlantic Hearth largely depended on tidewater irrigation systems, whereas the rice growers in southern Louisiana along the Lower Mississippi River employed various devices to draw irrigation water from the rivers. In the Gulf Coast Prairies and in the Lower Mississippi River Valley, both surface water and ground water was drawn to rice fields through canal systems or well systems. More recently, underground pipeline irrigation systems are widely employed in these rice-producing regions. The levee-making and land-leveling techniques are important in rice cultivation. The water-leveling technique, developed in 1960, has been widely applied for land leveling in southern rice farms. Recently, some farmers use laser equipments for land-leveling in southern rice fields.

Large-scale mechanization of rice farming began during the late nineteenth century. Rice threshers and binders were widely adopted in southern rice farms from the 1880s. Tractors were introduced in southern rice farms during World War One; combines were widely used from the latter part of World War Two. Airplane application for southern rice farming began in the 1940s, and at the present time the use of the planes for the application of all bulk materials is commonplace throughout the southern rice-producing areas.

Hundreds of rice varieties have been grown for commercial use in southern rice fields. Carolina Gold and Carolina White were the leading rice varieties in the South Atlantic Hearth. Carolina Gold also became popular in southern Louisiana after the Civil War, gradually being replaced by Honduras rice from the 1880s and by Japan rice from the 1890s. The Japan varieties were the leading varieties during the early years of this century, but in the 1910s yielded the leading position to Sol Wright's varieties, which were again replaced by the rice varieties distributed by the rice experiment stations in the latter part of the 1940s. Rice experiment stations have distributed newly developed varieties through introductions of new strains from abroad, selections of better lines from existing varieties, and cross-breeding of rice for better varieties.

Rice has been grown in rotation with pasture or other field crops. Rice was largely rotated with pasture, while cattle-raising was important in the rice-producing regions. Cattle raising was an important enterprise especially in the Gulf Coast Prairies and in the Grand Prairie from the time before a large-scale, mechanized rice culture was introduced there. Since the mid-1960s, rice-soybean rotation has become the most popular type of crop rotation in the rice-producing regions in the South. Fish-breeding, crawfish-raising, and duck-hunting have often brought supplementary income to southern rice growers. Various weeds, insects, muskrats, and birds have troubled southern rice growers since the early days of rice culture in the South. These have been controlled by various methods, but not yet completely controlled. Ratooning of rice has become popular in the Gulf Coast Prairies, especially in the western portion of Texas rice belt, since the early 1960s, but it has never proved to be practical along the Lower Mississippi River Valley.

Southern rice farmers benefited from various organizations and institutes. The Rice Millers Association, originally organized in 1902, has provided various statistical data on the rice industry. Rice-growers have organized their rice cooperatives for rice marketing, milling, and drying and storage. The cooperatives have developed into hierarchical organizations; therefore, local cooperatives are often members of the central cooperatives. The Rice Council for Market Development, organized first in 1957 as the Rice Industry, is a nation-wide rice promotion organization and local or state rice promotion organizations are subgroups of the Rice Council. The experiment stations in southern rice-producing states have conducted research on rice, and benefited southern rice growers through the results of their research.

The role of government has become active in the rice industry through the production control and price support systems since the enactment of the Agricultural Adjustment Act of 1933. The effectiveness of the government programs and policies have been severely affected by the international situation. Price and income support is emphasized in recent rice policies.

If only physical environment for the plant of rice is considered, the potential of rice production in the American South seems to be tremendous. But the future of southern rice industry depends on various human factors. The major important factor is associated with rice price, which is largely determined by international demand for rice and supply of the crop. A slight increase in national consumption would be favorable for the U.S. rice industry.

Another important is the relative importance of land uses of other field crops: soybeans, pastures, sugarcane, or cotton. Rice is competitive with other crops in land use; therefore, the expansion or reduction of other crops' acreage will affect the rice culture. Finally, the development of the agricultural technology for rice farming may reduce the production cost and give the crop a preferable condition in the international market.

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Appendix I. Exports of Milled Rice Shipped from the United States, 1712-1860 (Source: Gray, L. C. 1958. *History of Agriculture in the United States*. Gloucester, Mass.: Peter Smith, p. 1030) (1 unit = 1,000 cwt. = 100,000 pounds)

Year	Exports	Year	Exports	Year	Exports
1712-16 (average)	31.44	1767	682.67	1819	429.98
1717	31.87	1768	672.34	1820	529.33
1718	31.90	1769	754.92	1821	522.53
1719	54.44	1770	765.11	1822	608.19
1721	87.52	1771	700.00	1823	679.37
1724	70.94	1772	680.78	1824	582.09
1725	92.12	1773	625.38	1825	666.38
1726	107.54	1782	121.12	1826	801.11
1727	119.62	1783	309.87	1827	1,050.11
1728	129.54	1784	318.57	1828	1,029.82
1729	166.89	1785	329.29	1829	784.18
1730	197.44	1786	325.98	1830	699.10
1731	185.34	1788	500.00	1831	721.96
1732	253.63	1789	605.07	1832	864.98
1733	151.62	1790	741.36	1833	731.32
1734	228.66	1791	850.57	1834	665.11
1735	264.85	1792	807.67	1835	1,277.90
1736	214.13	1793	698.92	1836	636.50
1737	171.62	1794	831.16	1837	426.29
1738	357.42	1795	786.23	1838	559.92
1739	455.55	1796	360.67	1839	609.96
1740	404.47	1797	751.46	1840	609.70
1741	230.98	1798	663.59	1841	687.70
1742	367.08	1799	672.34	1842	640.60
1743	403.89	1800	569.20	1843	808.29
1744	298.14	1801	478.93	1844	711.73
1745	270.51	1802	491.03	1845	744.04
1746	270.73	1803	470.31	1846	866.56
1747	275.66	1804	340.98	1847	602.42
1748	205.17	1805	615.76	1848	773.17
1749	241.11	1806	568.15	1849	762.41
1750	308.06	1807	55.37	1850	633.54
1751	392.17	1808	701.44	1851	718.40
1752	177.61	1809	788.05	1852	406.24
1753	523.41	1810	716.14	1853	630.73
1754	483.89	1811	463.14	1854	394.22
1758	259.42	1812	725.06	1855	676.16
1759	304.03	1813	68.86	1856	683.23
1760	523.42	1814	775.49	1857	581.22
1761	435.92	1815	827.06	1858	770.70
1762	505.30	1816	475.78	1859	816.33
1763	509.21	1817	529.09	1860	435.12
1764	536.46	1818	459.14		

Appendix II. Rice (Rough Rice) Production in the United States, 1839-1934 (Compiled from the U.S. Census of Agriculture)

(1 unit = 1 cwt. = 100 pounds = 100/45 bushels)

	1934	1929	1924	1919
US	14,830,985	15,061,042	13,286,494	15,898,910
Ark.	2,881,510	3,131,147	3,198,563	3,058,707
Tx.	2,473,884	2,321,345	2,881,377	2,387,866
La.	6,524,615	7,342,858	5,530,174	7,205,250
Miss.	3,072	416	378	8,163
Mo.	3,045	5,092	27,189	13,421
Ala.	3,613	836	1,543	6,425
Fl.	2,813	2,195	5,215	17,621
Ga.	5,442	8,231	11,562	26,870
S.Car	20,638	13,141	28,363	55,109
N.Car	371	24	11	1,695
Tenn.	---	---	---	19
N.Mex	---	---	---	922
Calif	2,911,982	2,235,757	1,602,120	3,116,841

	1909	1899	1889	1879
US	9,827,361	4,051,299	2,081,508	1,782,702
Ark.	577,274	140	115	---
Tx.	4,046,285	116,334	1,755	1,006
La.	4,877,988	2,796,029	1,224,477	375,350
Miss.	2,176	11,966	10,954	27,825
Ala.	2,326	15,004	6,463	13,126
Fl.	5,553	36,494	16,378	20,957
Ga.	66,914	180,883	235,626	410,660
S.Car.	243,707	766,621	491,098	842,981
N.Car.	5,111	127,758	94,636	90,796

	1869	1859	1849	1839
US	1,191,934	3,029,682	3,485,291	1,308,584
Ark.	1,182	272	1,023	88
Tx.	1,033	421	1,428	---
La.	256,630	102,484	71,633	58,347
Miss.	6,064	13,097	44,027	12,581
Mo.	---	158	11	1
Ala.	3,609	7,988	37,428	2,412
Fl.	6,502	3,621	17,402	7,792
Ga.	360,605	849,944	630,497	200,472
S.Car.	522,920	1,927,886	2,588,805	980,787
N.Car.	33,334	122,924	88,476	45,654
Tenn.	55	653	4,190	129
Va.		133	278	48

Appendix III. Rice (Rough Rice) Production in the United States, 1895-1985 (Compiled from the Annual Reports "Agricultural Statistics" of the U.S. Dept. of Agriculture and the Annual Reports "Production of Rough Rice in the United States" of the Rice Millers Association) (1 unit = 1,000 cwt =100,000 pounds =100,000/45 bushels =100,000/162 barrels)

Year	US *	Ark.	La.	Texas	Miss.	Mo.	Calif.
1985	136,042*	54,600	20,256	18,071	10,058	3,463	29,594
1984	138,810*	52,900	21,932	20,160	8,265	3,493	32,060
1983	99,720*	39,159	14,693	13,805	6,440	2,534	23,089
1982	153,637*	57,037	24,862	22,214	10,094	3,582	35,848
1981	182,742*	69,610	27,078	27,239	14,792	3,099	40,924
1980	146,150*	52,615	20,768	24,814	9,226	2,341	36,386
1979	131,947*	44,064	20,643	23,481	8,384	1,333	34,042
1978	133,170*	48,505	22,425	26,226	9,138	1,298	25,578
1977	99,223*	35,396	17,445	23,400	4,440	629	17,913
1976	115,648*	40,362	22,203	24,430	6,048	588	22,017
1975	127,972*	40,053	25,064	24,996	6,665	758	30,436
1974	112,394*	32,879	24,090	25,258	4,513	544	25,110
1973	92,765*	25,424	21,394	20,530	2,670	226	22,521
1972	85,439*	21,939	19,967	22,122	2,325	218	18,868
1971	85,768*	22,271	19,836	23,868	2,346	235	17,212
1970	83,805*	21,024	20,397	21,015	2,295	207	18,867
1969	90,838*	24,463	20,469	21,646	2,520	248	21,492
1968	104,075*	24,596	26,142	27,164	2,881	288	23,004
1967	89,379*	21,704	22,035	25,400	2,365	235	17,640
1966	85,020*	20,511	20,905	21,210	2,365	229	19,800
1965	76,281*	18,662	18,282	21,252	1,850	212	16,023
1964	73,142*	18,490	16,929	19,173	1,838	198	16,514
1963	70,269*	18,318	16,891	18,934	1,911	202	14,013
1962	66,045*	16,401	15,494	16,401	1,568	193	15,988
1961	54,198*	13,440	13,396	11,861	1,452	129	13,920
1960	54,591*	13,536	13,053	12,823	1,298	129	13,752
1959	53,438*	13,022	12,910	12,927	1,188	139	13,252
1958	44,381*	9,912	10,812	11,370	1,092	115	11,080
1957	42,935*	10,292	10,700	11,104	992	129	9,718
1956	49,459*	12,224	12,150	11,687	1,254	132	12,012
1955	55,902*	13,562	14,728	14,640	1,482	140	11,350
1954	64,193*	16,800	15,956	17,040	2,021	212	12,164
1953	52,607*	11,300	12,684	15,068	1,298	-----	12,257
1952	48,107*	9,420	12,056	13,800	1,116		11,715
1951	45,797*	9,011	11,934	13,514	662		10,676
1950	38,689*	7,780	10,882	11,568	189		8,270
1949	40,747*	8,856	10,782	10,740	135		10,234
1948	38,275*	9,220	11,216	11,007	-----		6,832
1947	35,217*	7,652	9,931	9,599			8,035
1946	32,497*	6,408	10,204	7,972			7,913
1945	30,668*	5,943	10,363	8,100			6,262
1944	30,672*	6,568	9,593	7,762			6,750

Year	US *	Ark.	La.	Tx.	Miss.	Mo.	Calif.
1943	29,179*	5,351	9,769	7,508			6,552
1942	29,047*	5,689	10,517	7,160			5,682
1941	23,095*	4,913	9,180	5,215			3,787
1940	24,495*	4,315	8,442	7,490			4,248
1939	24,175*	3,794	9,504	6,827			4,050
1938	23,628*	4,372	9,337	6,151			3,769
1937	24,017*	4,763	9,306	5,850			4,099
1936	22,051*	3,938	9,484	4,774			3,855
1935	17,453*	2,732	7,783	3,908			3,029
1934	17,233*	3,121	7,181	3,482			3,449
1933	16,943*	3,057	7,018	3,306			2,822
1932	18,729*	3,290	7,586	3,901			3,357
1931	20,076*	4,035	7,637	4,777			3,674
1930	20,218*	3,873	9,101	4,081			3,324
1929	17,790*	3,269	8,900	3,279			2,866
1928	19,725*	3,506	8,337	3,407			3,804
1927	20,024*	3,470	8,714	3,347			4,246
1926	18,911*	4,547	7,143	2,864			3,797
1925	14,866*	3,399	6,542	2,714			2,031
1924	14,689*	3,164	6,589	2,537			2,028
1923	14,957*	2,330	7,188	2,605			2,798
1922	18,748*	3,489	8,899	2,642			3,977
1921	17,673*	3,485	8,392	2,542			3,418
1920	23,242*	3,880	11,871	4,355			2,995
1919	19,210*	3,083	7,817	2,843			3,459
1918	17,999*	2,851	7,676	3,379			3,256
1917	15,621*	2,770	7,418	2,667			2,595
1916	17,795*	2,701	8,722	4,523			1,396
1915	11,748*	2,200	5,816	3,442			815
1914	10,565*	1,895	5,197	3,366			502
1913	10,894*						
1912	10,665*						
1911	10,198*						
1910	11,129*						
1909	10,614*						
1908	10,079*						
1907	9,338*						
1906	7,999*						
1905	7,217*						
1904	8,647*						
1903	8,590*						
1902	6,541*						
1901	5,702*						
1900	4,406*						
1899	4,029*						
1898	3,737*						
1897	3,084*						
1896	2,340*						
1895	3,341*						

Appendix IV. Rice (Rough Rice) Yield per Acre in the United States, 1895-1985 (Compiled from the Annual Reports "Agricultural Statistics" of the U.S. Dept. Agriculture and the Annual Reports "Rice Acreage of the United States" of the Rice Millers Association)

(1 unit = 1 pound = 1/45 bushel = 1/162 barrel)

Year	US	Ark.	La.	Texas	Miss.	Mo.	Calif.
1985	5,437	5,200	4,370	5,490	5,350	4,810	7,400
1984	4,954	4,600	4,150	4,940	4,350	4,600	7,120
1983	4,598	4,280	3,820	4,340	4,000	4,090	7,040
1982	4,710	4,290	4,160	4,690	4,120	4,480	6,700
1981	4,819	4,520	4,060	4,700	4,390	4,080	6,900
1980	4,413	4,110	3,550	4,230	3,840	4,180	6,440
1979	4,599	4,320	3,910	4,220	4,050	3,810	6,520
1978	4,484	4,450	3,820	4,700	4,250	4,330	5,220
1977	4,412	4,230	3,670	4,670	4,000	3,700	5,810
1976	4,663	4,770	3,910	4,810	4,200	4,200	5,520
1975	4,558	4,540	3,810	4,560	3,900	4,210	5,800
1974	4,440	4,535	3,650	4,494	4,180	3,886	5,380
1973	4,274	4,770	3,451	3,740	4,306	4,346	5,616
1972	4,700	4,975	3,825	4,727	4,559	4,449	5,700
1971	4,718	5,050	3,800	5,100	5,200	4,796	5,200
1970	4,615	4,800	3,900	4,500	4,500	4,404	5,700
1969	4,268	4,750	3,350	3,950	4,200	4,593	5,525
1968	4,422	4,300	3,850	4,550	4,300	4,500	5,325
1967	4,537	4,550	3,900	5,000	4,300	4,608	4,900
1966	4,322	4,300	3,700	4,200	4,300	4,404	5,500
1965	4,255	4,300	3,550	4,600	3,700	4,511	4,900
1964	4,098	4,300	3,300	4,150	3,751	4,304	5,050
1963	3,968	4,300	3,325	4,125	3,900	4,208	4,325
1962	3,726	3,850	3,050	3,550	3,200	4,196	4,950
1961	3,411	3,500	2,925	2,900	3,300	3,308	4,800
1960	3,423	3,525	2,850	3,075	2,950	3,395	4,775
1959	3,382	3,400	2,850	3,100	2,700	3,390	4,650
1958	3,164	2,950	2,650	3,000	2,800	3,108	4,450
1957	3,204	3,100	2,675	3,200	3,200	3,308	4,300
1956	3,151	3,200	2,700	2,900	2,850	3,300	4,200
1955	3,061	3,125	2,800	3,050	2,850	2,800	3,450
1954	2,517	2,500	2,350	2,675	2,625	2,625	2,550
1953	2,447	2,325	2,100	2,625	2,449	-----	2,975
1952	2,413	2,075	2,075	2,500	2,325		3,550
1951	2,309	2,025	1,950	2,375	2,452		3,400
1950	2,371	2,275	1,975	2,400	2,700		3,475
1949	2,194	2,225	1,800	2,000	2,700		3,400
1948	2,122	2,407	1,777	2,093	-----		2,835
1947	2,062	2,138	1,620	2,025			3,240
1946	2,054	2,003	1,732	1,935			3,128
1945	2,064	2,115	1,777	2,025			2,723
1944	2,093	2,363	1,710	1,980			2,813

Year	US	"	Ark.	La.	Texas	Miss.	Mo.	Calif.
1943	1,988	"	2,115	1,620	1,935			2,925
1942	1,996	"	2,205	1,710	1,935			2,745
1941	1,902	"	2,318	1,688	1,710			2,475
1940	2,291	"	2,259	1,800	2,574			3,600
1939	2,328	"	2,219	1,980	2,538			3,015
1938	2,196	"	2,313	1,890	2,295			3,015
1937	2,187	"	2,520	1,800	2,340			3,105
1936	2,285	"	2,461	1,980	2,340			3,060
1935	2,173	"	1,980	1,890	2,340			3,060
1934	2,164	"	2,295	1,822	2,385			3,285
1933	2,123	"	2,074	1,803	2,268			2,666
1932	2,143	"	2,107	1,881	2,122			3,051
1931	2,080	"	2,160	1,632	2,352			2,977
1930	2,093	"	2,254	1,835	2,235			3,022
1929	2,069	"	2,041	1,929	2,325			2,985
1928	2,029	"	2,101	1,736	2,128			2,760
1927	1,950	"	1,930	1,800	2,092			2,605
1926	1,861	"	2,391	1,415	1,732			2,515
1925	1,743	"	1,985	1,687	1,758			1,847
1924	1,753	"	2,028	1,367	1,717			2,444
1923	1,711	"	1,746	1,366	1,737			2,627
1922	1,780	"	2,206	1,298	1,514			2,764
1921	1,785	"	2,710	1,844	1,863			2,532
1920	1,789	"	2,034	1,629	1,561			2,285
1919	1,783	"	1,775	1,402	1,205			2,479
1918	1,635	"	1,696	1,321	1,387			2,505
1917	1,639	"	1,914	1,465	1,140			3,053
1916	2,111	"	2,217	1,953	1,930			2,024
1915	1,588	"	2,138	1,463	1,326			2,591
1914	1,635	"	2,025	1,557	1,421			3,240
1913	1,509	"						
1912	1,659	"						
1911	1,603	"						
1910	1,671	"						
1909	1,603	"						
1908	1,692	"						
1907	1,661	"						
1906	1,584	"						
1905	1,580	"						
1904	1,508	"						
1903	1,571	"						
1902	1,201	"						
1901	1,350	"						
1900	1,219	"						
1899	1,193	"						
1898	1,188	"						
1897	1,062	"						
1896	869	"						
1895	1,143	"						

Appendix V. Rice Journal and Rice Farming

The Rice Journal was first published under the name Rice Journal and Gulf Coast Farmer in December 1897. Dr. Seaman A. Knapp was the founder and first editor of the journal and was a steady contributor. The journal has undergone several name changes: Rice Journal with variant subtitles (1898 to 1934), Rice, Sugar, and Coffee Journal (1935 to April 1937), Rice and Sugar Journal (May 1937 to May 1938), and Rice Journal (from June 1938 to present). The journal has covered all kinds of subjects related to rice. However, since the main office of the journal was moved from New Orleans to Washington, D.C., in October 1971, the journal has added a broader emphasis on aspects of government policies affecting the rice industry in the United States.

The Rice Farming magazine has been published monthly since January 1967. The format and subjects of the magazine are not so much different from those of the Rice Journal, but Rice Farming is a little more oriented to cultivation practices for rice. Interviews with southern rice farmers are most frequently published in this magazine.

Both the Rice Journal and the Rice Farming, though they may be popular magazines, often distribute the results of scientific studies on rice farming. Farmers can exchange information on their successful farming methods and discuss relevant problems among themselves. The two magazines are also valuable in that they record in detail the development of rice culture and the rice industry in the United States.

Appendix VI. Percentages of Rice Varieties in Arkansas, 1984-1987 (Source: the Cooperative Extension Service of University of Arkansas, USDA, and County Governments Cooperating. 1988. Leaflet 518: Rice varieties in Arkansas)

Variety	1984	1985	1986	1987
Newbonnet	5.1	61.2	68.9	54.5
Starbonnet	41.8	2.9	0.5	0.2
Lemont	1.4	12.2	11.4	16.7
Tebonnet	---	3.2	9.2	13.2
Lebonnet	20.1	5.5	1.2	1.3
Labelle	18.8	4.1	0.7	0.9
Bond	3.6	5.6	0.8	0.2
Mars	7.4	4.3	6.9	10.8
Newrex	0.6	0.3	0.3	0.4
Nortai	0.1	0.1	0.1	0.3
L202	---	---	---	0.9
Gulfmont	---	---	---	0.2
Rexmont	---	---	---	0.1
Skybonnet	NA	NA	NA	0.3
Total %	98.9 %	99.4 %	100.0 %	100.0 %

Appendix VII. The Percentages of Bella Patna Acreage and Bella Patna Production of the State Total in Texas, in Louisiana, and in Arkansas (Source: Annual reports of the Rice Millers Association)

Year	Texas	Louisiana	Arkansas
1961	0.8 (1.0)	0	0
1962	19.0 (27.0)	1.3 (1.3)	0.4 (0.4)
1963	30.2 (37.8)	1.4 (2.7)	0.5 (0.5)
1964	53.9 (55.1)	4.7 (4.3)	1.1 (1.1)
1965	64.1 (66.3)	2.6 (2.4)	1.8 (1.7)
1966	60.1 (62.5)	4.7 (4.7)	5.5 (5.2)
1967	37.9 (38.2)	5.0 (4.9)	5.6 (5.0)
1968	29.1 (28.9)	6.5 (6.8)	2.8 (2.6)
1969	34.2 (32.8)	5.1 (4.8)	1.9 (1.8)
1970	31.8 (32.2)	2.9 (2.8)	1.0 (0.9)
1971	35.5 (35.7)	4.6 (4.4)	0.6 (0.5)
1972	37.1 (37.1)	5.2 (5.2)	0.5 (0.5)
1973	19.9 (20.6)	3.1 (3.4)	1.4 (1.4)

Appendix VIII. The Percentages of Labelle Acreage and Labelle Production of the State Total in Texas, in Louisiana, and in Arkansas (Source: Annual Reports of the Rice Millers Association)

Year	Texas	Louisiana	Arkansas
1973	33.9 (35.4)	1.9 (2.2)	0.3 (0.3)
1974			
1975	68.1 (71.3)	7.0 (7.7)	8.3 (7.5)
1976	79.6 (81.3)	11.3 (11.2)	7.6 (6.5)
1977	87.9 (88.5)	16.5 (16.2)	7.3 (6.8)
1978	87.9 (88.4)	17.0 (16.9)	11.4 (10.2)
1979	93.6 (94.0)	16.9 (16.1)	14.7 (15.1)
1980			
1981	85.4 (85.7)	13.7 (13.2)	18.9 (19.4)
1982	86.3 (86.8)	21.5 (21.6)	19.1 (19.1)
1983	81.8 (80.8)	21.0 (26.8)	21.9 (19.5)
1984	52.7 (50.6)	25.7 (22.0)	20.4 (19.4)

Appendix IX. Season Average (Rough Rice) Price per Bag Received by Farmers (Compiled from Agricultural Statistics of the U.S. Dept. of Agriculture)

(1 bag is equivalent to 100 pounds; 1 price unit =1 dollar)

Year	Price"	Year	Price"	Year	Price"	Year	Price"	Year	Price
1904	1.46"	1921	2.18"	1938	1.42"	1955	4.81"	1972	6.73
1905	2.10"	1922	2.19"	1939	1.62"	1956	4.86"	1973	13.80
1906	2.01"	1923	2.49"	1940	1.80"	1957	5.11"	1974	11.20
1907	1.91"	1924	2.99"	1941	3.01"	1958	4.68"	1975	8.35
1908	1.80"	1925	3.30"	1942	3.61"	1959	4.59"	1976	7.02
1909	1.76"	1926	2.51"	1943	3.96"	1960	4.55"	1977	9.49
1910	1.47"	1927	2.02"	1944	3.93"	1961	5.14"	1978	8.16
1911	1.75"	1928	2.03"	1945	3.98"	1962	5.04"	1979	10.50
1912	1.98"	1929	2.22"	1946	5.00"	1963	5.01"	1980	12.80
1913	1.98"	1930	1.74"	1947	5.97"	1964	4.90"	1981	9.05
1914	1.98"	1931	1.08"	1948	4.88"	1965	4.93"	1982	8.11
1915	1.86"	1932	.93"	1949	4.10"	1966	4.95"	1983	8.76
1916	2.19"	1933	1.73"	1950	5.09"	1967	4.97"	1984	8.06
1917	4.26"	1934	1.76"	1951	4.82"	1968	5.00"	1985	7.90
1918	3.99"	1935	1.60"	1952	5.87"	1969	4.95"		
1919	5.46"	1936	1.85"	1953	5.19"	1970	5.17"		
1920	5.46"	1937	1.46"	1954	4.57"	1971	5.34"		

Appendix X. Summary of the 1988 USDA Provisions for the Rice Program (Source: R.J. February 1988, p. 22)

1. The national average level of rice price support for the 1988 rice crop is set at $6.63 a cwt.
2. The established target price will be $11.15.
3. The differential between whole kernel milled rice price support rates is established at $1 a cwt, unchanged from the 1987 crop. Whole kernel milled rice price support rates are $10.89 a cwt for log grain and $9.89 a cwt for medium and short grain rice. The broken kernel rate for all classes is $5.45 a cwt.
4. The acreage reduction [ARP] for the 1988 rice program is 25 percent.
5. Producers having 1988-crop rice pledged as collateral for price support loans will not be permitted to purchase marketing certificates and retain loans at the marketing loan payment rate.
6. Payments based on the difference between the 1988 loan rate and the loan payment rate [loan deficiency payments] will not be offered to producers who agree to forgo obtaining a loan or purchase agreement in return for these payments.
7. The discretionary inventory reduction program [one-half acreage reduction program] will not be implemented.
8. Advance deficiency payments may be requested at signup and will be 40 percent of the estimated deficiency rate of $1.65 a cwt. One-half of this amount will be paid in cash at signup and the balance will be paid in generic commodity certificates on or about May 15.
9. 1988 program payment yields will be set based on the average of program payment yields established for each farm for the 1981-85 crop years, excluding the highest and lowest yields. However, if this calculation results in a yield below 90 percent of the 1985 program payment yield, producers will be compensated to ensure they receive the same return as if the yield had not been reduced more than 10 percent.
10. The signup period is February 15 through April and is common for the 1988 crops of wheat, feed grain, cotton and rice.
11. April 15 is the date for determining the status of individuals of entities in applying the 1988 maximum payment limitation requirements.

Appendix XI. U.S. Rice (Milled Rice) Export under the PL-480, 1954-1984 (Compiled from the Agricultural Statistics of the U.S. Department of Agriculture) (1 unit = 1,000 cwt)

	Title I (sales)		Title II (donations)		Title III		Title IV
Year (1)	Sales for foreign currency	Long-term credit sales	Government-to government-ment	Voluntary relief agencies	Barter for strategic materials	Foreign donations	Long-term dollar credit sales
1985		5,700	480	711			
1984		9,599	2,051	1,072			
1983		6,443	2,006	1,780			
1982		8,829	988	657			
1981		6,603	1,254	378			
1980		5,449	1,583	893			
1979		8,889	1,888	1,087			
1978		9,224	1,135	315			
1977		10,275	1,045	345			
1976		14,572	198	357			
(2)		*10,007					
1975		11,228					
1974		16,342	113	11			
1973		13,352					
1972		21,253	722	4			
1971	3,588	14,343	5,462				
1970	5,366	14,979					
1969	9,782	10,925	22	142			
1968	6,626	15,053		208			
1967	12,656	3,535					
1966	15,498						2,763
1965	7,204						716
1964	11,187						759
1963	13,634						1,072
1962	12,696			14			770
1961	8,246			471			
1960	11,873			382	347	1,751	
1959	9,873			543	754	1,427	
1958	3,883			68	2,012	741	
1957	5,049			485	13	592	
1956	18,020			566	644	2,235	
1955	2,530			1,932	205	749	
1954				305	5		

(1) Year beginning July 1 for 1954-1975, and Oct. 1 for 1975-1984
(2) Transition quarter July 1, 1976 to Sept. 30, 1976

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